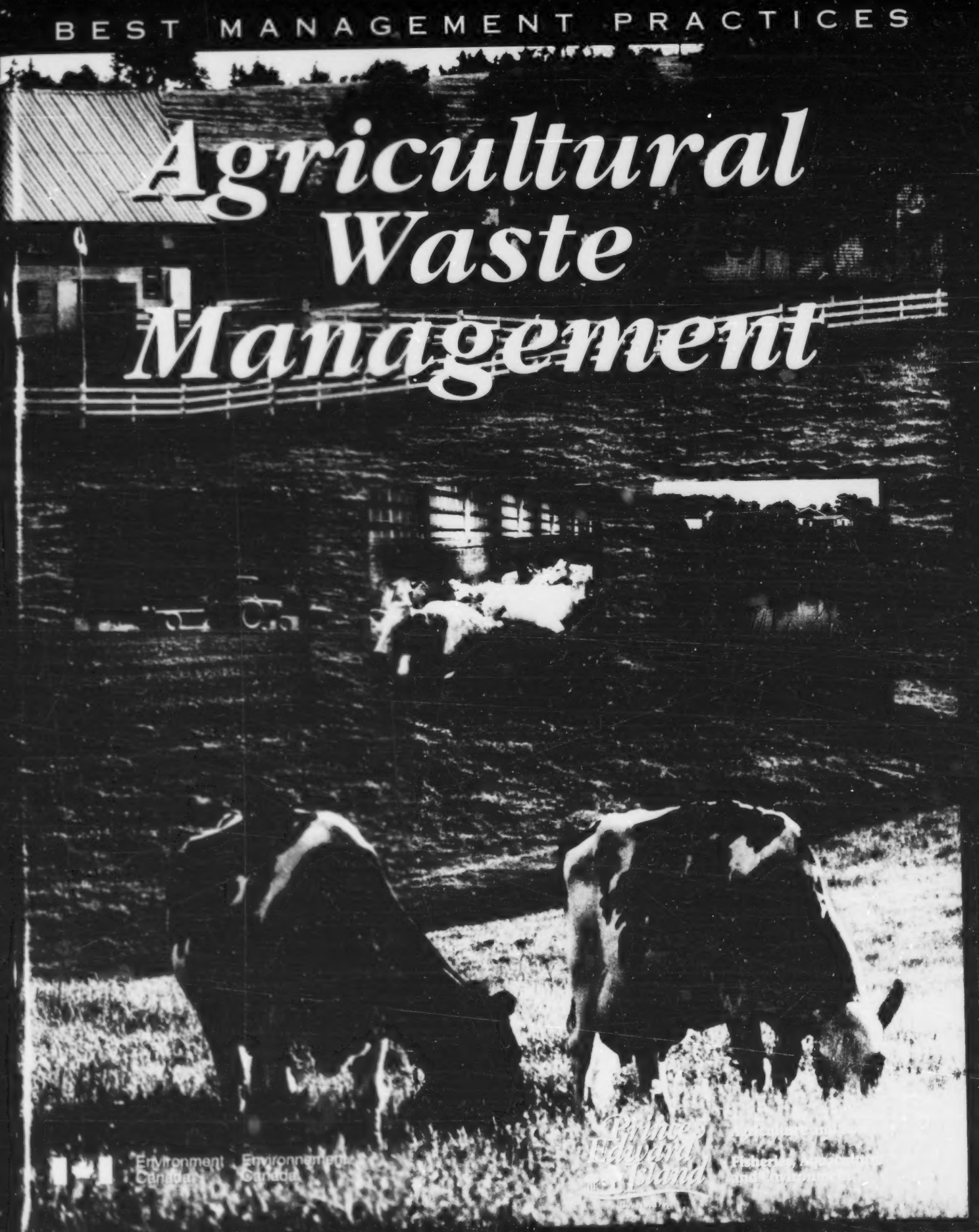
BEST MANAGEMENT PRACTICES

Agricultural Waste Management



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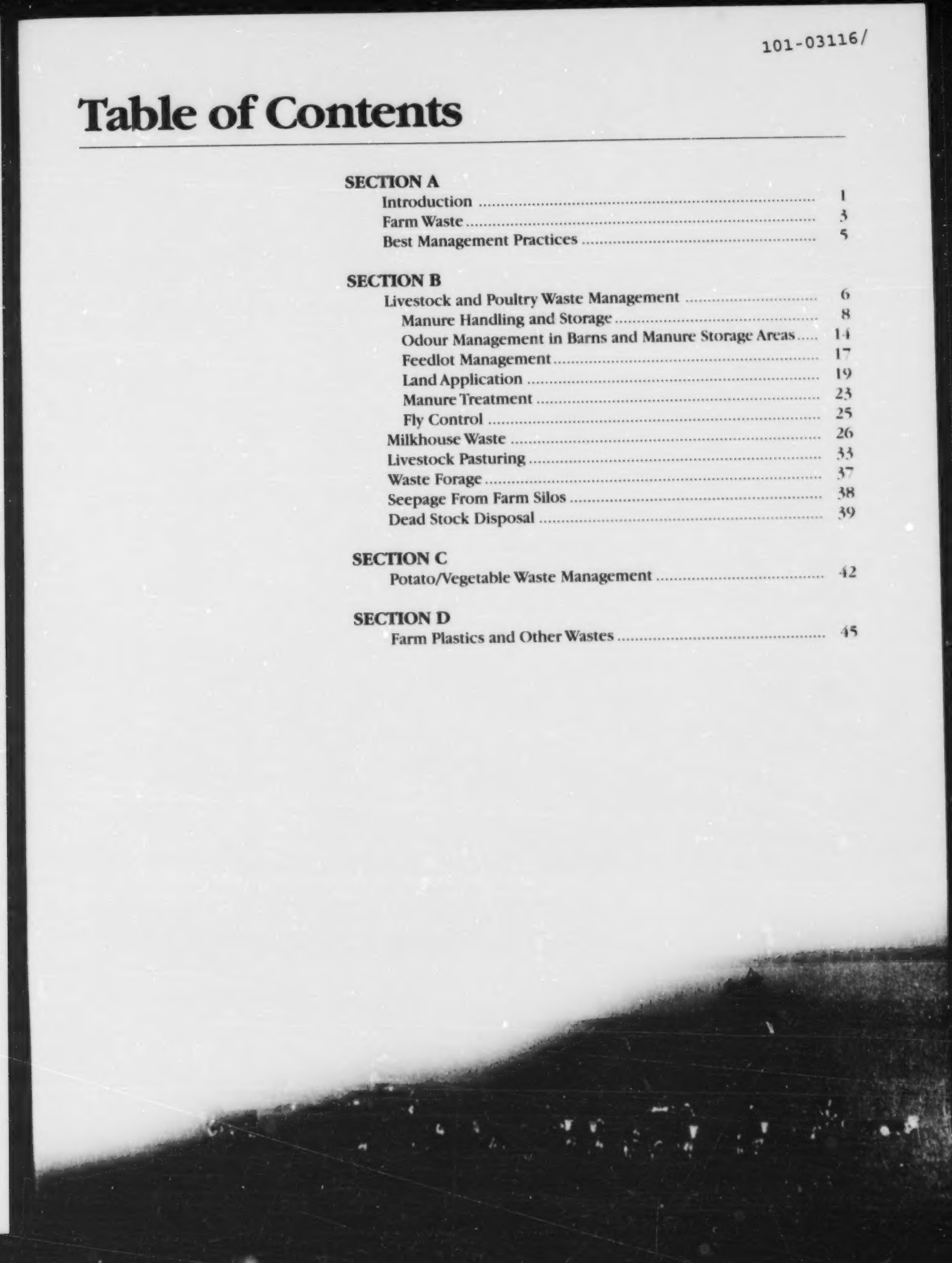

Section A - Introduction

Agriculture is the largest contributor of any resource sector, to the economy of Prince Edward Island. It is also a large generator of waste materials.

This booklet is a practical guide to help the agricultural community continue to be more environmentally responsible and gain maximum return from their waste resources. Achieving environmental objectives in an increasingly competitive business climate requires access to the best and most up-to-date information available.

This booklet will:

- Provide practical information to maximize the benefits and minimize negative impacts of handling waste.
- Look at the environmental risks associated with some waste management practices.
- Describe management and facility options for dealing with waste.
- Compare the potential impact of various options.
- List contacts and other suggested readings.

It will not answer every question on waste management but it can help make decisions on farm planning and day-to-day operations.

Environmental Farm Plans

This booklet is designed to be used as a supplemental resource document to the Environmental Farm Plan workbook developed by the Atlantic Farmers Council. Farm plans are developed by individual farm families to help them identify areas of potential environmental risk on their farm.

The planning process begins with an individual farm review under each of the following categories:

- soil and site characteristics
- farmstead and homestead
- livestock and poultry
- soil and crop management
- sensitive ecological areas
- hedgerows

The next step is to develop an action plan to address identified areas of concern. Farmers need to analyze their situation and decide what can be done and when.

Farm planning highlights opportunities for pursuing both business and environmental objectives at the same time. Planning will also help farm operators decide what tradeoffs might be effective when business and environmental objectives compete. Understanding the best management practices is an essential part of developing a sustainable farm plan.

Technical advice is available from the Department of Agriculture and Forestry and Department of Fisheries, Aquaculture and Environment.

This booklet is presented in four sections:

Introduction

- outlines the environmental challenge presented by agricultural waste management.
- introduces how best management practices can be used on the farm to protect, conserve and reuse resources while minimizing negative impacts on the environment.

Livestock and Poultry Waste Management

- discusses waste management in the livestock and poultry sectors.
- emphasis is placed on manure management, feedlot and pasture management, milkhouse wastes and dead stock disposal.

Horticultural Waste Management

- discusses potato, other vegetable and fruit wastes.
- highlights the environmental concerns associated with handling wastes.
- suggests acceptable options for disposal.

Farm Plastics

- discusses the best management practices for handling farm plastics in both the livestock and horticultural sectors.

Farm Waste

The first goal of any waste management system is to maximize the economic benefit from the waste resource and maintain acceptable environmental standards. To be practical, the system must also be affordable and suitable to the operation. If wastes are not properly handled they can pollute surface and groundwater and contribute to air pollution.

Most people think of manure first when they think of farm waste. While manure is an important component, farm waste in a livestock operation can also include waste forage, dead stock, silage effluent and milkhouse waste. In horticultural operations, culls, diseased product, wash line sediment and processing plant wastes are common by-products.

In addition to these, all farm operations generate plastic waste material ranging from silage wrap to pesticide or drug containers.

Management that puts into practice the principles of the four Rs of Reduce, Reuse, Recycle and Recover is the best first option:

- Reduce the amount of waste product generated;
- Reuse the waste product on the farm or provide it for others to use; and
- After reducing and reusing as much of the waste product as possible, recycle the product either on-farm, such as with land application of manure, or off-farm, such as with plastic recycling programs.
- Recover methane gas from manure waste.

Only after considering the four Rs should farm waste be disposed of.

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Farm Waste By-product as a Resource

Many farm by-products can be economically valuable resources when managed correctly. Manure, for example, is a valuable resource because of its fertilizing and soil conditioning properties. Horticultural washwater can be economically recycled. Farm plastics can be recycled or reused. If systems for storage and handling are substandard these wastes can degrade the environment on and off the farm.

Relevant Guidelines and Regulations

Farmers should be aware of the environmental guidelines and regulations which apply to farm operations in Prince Edward Island. These are:

Provincial	National
PEI Pesticide Control Act	Pest Products Control Act
PEI Plant Health Act	Fisheries Act
PEI Planning Act	Canadian Farm Building Code 1990
PEI Wildlife Conservation Act	Canadian Code of Practice for Environmentally Sound Hog Production (Canadian Pork Council)
PEI Environmental Protection Act	National Building Code of Canada
PEI Guidelines for Disposal of Cull Potatoes	
PEI Guidelines for Disposal of Dead Farm Livestock	
Guidelines for Manure Management for PEI	
PEI Farm Practices Act	

These documents are available from Island Information Service and local, federal and provincial resource departments.

Best Management Practices

Best Management Practices integrate principles of production, business goals, sustainability and environmental quality in farm resource management systems.

The best management practices (BMPs) referred to in this booklet are practical guidelines drawn from research and on-farm experience. They also reflect relevant regulatory requirements and approved guidelines.

The Challenge

Our society is increasingly concerned with the environmental consequences of all activities. Farming operations are no exception.

Our dependence on groundwater, the delicate balance of our coastal estuaries and the economic importance of tourism each provide ample reason to use the best management practices to handle wastes.

Green Consumerism

Accepting the environmental challenge and projecting a public image of good environmental stewardship can provide producers with a competitive advantage. While governments and international bodies propose formal solutions, consumers are encouraging changes in the marketplace. "Green consumerism" is a growing trend that is becoming an increasingly important factor at home and in many of the countries that are markets for Canadian agricultural products. Powerful consumer actions have the potential to affect the price and marketability of products. In a broader economic context, it is not acceptable to be competitive in the global marketplace at the expense of the environment.

Water

All water for human consumption and most water for other purposes on Prince Edward Island comes from groundwater. Because the upper layer of soil is generally thin and the underlying bedrock aquifer is extensively fractured, all areas on the Island are susceptible to groundwater contamination.

Fish and wildlife are dependant on clean surface water resources and their abundance contributes to the Island economy through tourism, sportfishing, hunting, trapping and wildlife observation. Coastal estuaries of Prince Edward Island have some of the most productive shellfish grounds in North America.

Climate

Agricultural activities both absorb and produce "greenhouse" gases. Gases such as carbon dioxide, methane and nitrous oxide block the escape of heat energy and produce a warming trend in the earth's atmosphere. Crop growth requires carbon dioxide while animal production and vehicle operation emit carbon dioxide. Improved treatment, handling and utilization of manure offers the greatest potential for the reduction of these gases from agricultural sources.

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Section B - Livestock and Poultry Waste Management

Manure Management

The increasing size of farm operations in Prince Edward Island and the expanding residential land use in rural areas has greatly increased environmental concerns over nuisance odours and the potential for water pollution. With good manure management practices, proper storage facilities, and adequate separation distances between non-compatible land uses, most environmental problems can be avoided.

Manure management encompasses manure collection, storage, transport and land application. The goal of manure management must be to maximize the soil amending value of manure and minimize the potential for environmental degradation.

Nature of the Resource

Manure and contaminated runoff water are valuable sources of fertilizer and organic matter for soil. Manure is a dynamic organic material, continually undergoing biological and chemical changes. The value of manure as a fertilizer depends on the quantity and form of nutrients present when it is applied to land. Each phase of management may result in losses of, or changes to, the beneficial nutrients in the manure.

Manure includes the faecal and urinary wastes of livestock and poultry, plus materials such as bedding and added water. The combined moisture level of faeces and urine ranges from 75% in poultry manure to 85% for swine manure. Depending on the amount of water or bedding added, manure can be solid, semi-solid or liquid.

Manure contains about 75% of the nutrients fed to livestock including nitrogen, phosphorus and potassium. Animals use only about 25% of nutrients and excrete the rest. About 50% of nitrogen and 75% of potassium in manure is found in the liquid portion. Therefore, it is important to contain the liquids for land application. Almost all the phosphorus is in the solids. When manure is diluted by water, nutrient concentrations are reduced.

Environmental Issues

Manure management practices have the potential to degrade the surrounding air and water. Odours are an unavoidable consequence of animal production and are the most apparent problem associated with manure. Minimizing problems associated with odours requires respect for individuals, in addition to good management practices.

Proper manure storage will minimize the impact on the natural environment.

Manure has potential to pollute surface water and groundwater through:

- direct animal access to waterways
- runoff from manure stockpiles, barn yards and feedlots
- seepage from manure storage areas
- overflow from storage areas
- runoff from fields where manure has been applied
- runoff from pastures

Surface water problems which may result include:

- harmful effects on fish from oxygen depletion in streams, ponds, and estuaries
- nutrient enrichment of water systems due to increased levels of nitrates and phosphates which can cause eutrophication (algae blooms) of surface waters
- human and animal health hazards including high concentrations of bacteria in shellfish

Manure and associated wastewater can be farm liabilities if they are not handled properly. Potential liabilities include:

- Bacterial and nitrogen contamination of water supplies.
- Potential disease in humans and livestock due to pathogenic bacteria.
- Dangerous gases produced in manure storage in the absence of oxygen. These gases include ammonia; methane, which is odourless; and hydrogen sulphide, which smells like rotten eggs. High concentrations of these gases can be harmful to the health of animals and humans.

Manure Handling and Storage

Livestock manure is classified as either a solid, semi-solid or liquid using the following criteria:

- ***Solid*** - contains greater than 20% solids. Bedding material contributes to the solids content of the manure. It can be stacked and handled by any equipment that will move bulk materials
- ***Semi-solid*** - (also referred to as slurry) - contains 5% to 20% solids. Semi-solid manure is produced in livestock housing systems where limited bedding is supplied. The resulting semi-solid does not flow as readily as liquid manure, nor can it be piled like solid manure.
- ***Liquid*** - contains less than 5% solids. The additional liquid comes from washing and spillage from watering systems. When agitated, liquid manure can be pumped or moved by gravity flow. Milkhouse wash-water and other types of waste-water are often added to the liquid manure. Manure which includes bedding or waste feed will require dilution if it is to be handled as a liquid.

The moisture content of the manure determines the type of handling and storage system. Most new swine and dairy operations use liquid systems, while the majority of beef and poultry producers on Prince Edward Island have solid manure handling systems.

Liquid manure storage - circular concrete tank.

Storage

A manure storage facility which is of sufficient size reduces the chance of pollution from spills and allows land application to take place when soil is dry, when crops require nutrients, and when work schedules permit.

- Manure storage should be large enough to store manure, bedding, wasted feed, precipitation and all liquids for at least 210 days. A one year storage capacity is optimal.
- On PEI, the required volume of open manure storages and confinement yards will have to be increased by 0.6 cubic metres/sq metre (2 cubic feet/sq ft) of surface area to allow for precipitation.

Solid manure storage - curbed concrete slab with ramp.

In barn storage - manure pack.

- Proper management of all liquids is essential for effective and economical manure handling and storage. Since all water which comes into contact with manure must be handled as a waste, the key to efficient management is to minimize that contact.
- Surface runoff should be diverted away from livestock and manure storage areas.
- Runoff from solid manure storage and exercise yards, milking centre washwater, silo seepage and livestock housing washwater must be stored and properly handled to ensure that groundwater, streams and other surface waters are not polluted.

Solid Manure

There are three common and acceptable ways of storing solid manure. These are related to the kind of livestock or poultry housing system in use. Farmers should consider animal density and roof costs versus the cost of runoff collection systems when planning a solid manure storage system.

In Barn (solid manure pack) - Manure can be stored where produced, in confined, bedded-pack housing systems. These are most commonly used for dairy and beef cattle. Dry manure poultry housing systems also store the manure where poultry are housed.

Solid or semi-solid manure storage - concrete slab with sidewalls and drive-in ramp.

Curbed concrete slab with runoff retention - Manure is removed and stored on a curbed concrete pad with a runoff containment system. Manure is usually moved by a tractor with a scraper blade, a front-end loader, a stable cleaner and elevator/stacker or by a ram/piston pump/air mover system.

Curbed concrete slab with roof - Manure is removed to a roofed storage area with a concrete floor and partial sidewalls constructed of reinforced concrete.

Field Storage of Manure

Field storage of manure is a practice sometimes used in conjunction with reduced storage capacity at the barn. This practice is generally not recommended due to the high permeability of PEI soils and the fractured nature of the underlying bedrock. As well, frozen ground during the winter months can increase the risk of runoff. Loss of nutrient content of the manure can also be an important consideration.

Where the practice of field storage is used, a number of precautions should be employed. Field piles should not be located within 300 metres (984 ft) of a public water supply or within 90 metres (300 ft) of a watercourse, natural wetland or residential well. Manure piles should not be located in areas subject to accumulated surface runoff or where flooding can occur. Discharge of contaminated runoff to road ditches should not be permitted.

Semi-Solid Manure

There are two common and acceptable ways of storing semi-solid manure.

Curbed concrete slab with earthen banks - This type of storage requires a sloped concrete floor, concrete curbs and ramp to allow easy tractor access. Earthen sidebanks must be properly designed and constructed to prevent seepage. Environmental approval will require certification by a qualified engineer. The sloped floor allows the liquid portion of the manure to flow to the lowest point, where it can be removed by pumping. The remaining solids can be removed by a tractor fitted with a front-end loader.

Concrete storage - Where soils are low in clay content, semi-solid manure may best be stored in a roofed structure with reinforced concrete sidewalls on three sides. A concrete floor sloping downward from the

Liquid manure storage - underbarn concrete storage with slatted floor (under construction).

open side is required to contain drainage of the liquid portion. The floor should be sealed at the walls to prevent seepage.

Liquid Manure

All liquid manure storages must have some type of impermeable enclosure, including concrete tanks, above-ground glass-lined steel tanks and earthen ponds. These storage systems can be covered or open. Liquid manure storages are most common in confined swine operations and free stall dairy systems. Common types of liquid manure storage on PEI are:

Underbarn Concrete Storage - Rectangular tanks with reinforced concrete walls sealed to a concrete floor; may be located below a slatted barn floor. Toxic and explosive gases may be produced when manure is agitated prior to removal, so barns should be well-ventilated.

Exterior Concrete Tank - Circular or rectangular tanks with reinforced concrete walls and floors; may be partially or entirely in-ground. Covers may be installed to reduce odours, to keep out precipitation or to ensure safe operation. Covers chosen to reduce the strong odours common to liquid storage can include temporary floating straw crusts, tarpaulins, plastic domes or permanent steel, wood or concrete structures. For safety reasons, in-ground or partially in-ground storage outside the barn must be fenced or have a reinforced concrete cover which will support vehicle traffic. The floor elevation of the storage must be 0.5 metres (1.6 ft) above the maximum water table and bedrock elevation.

Earthen Lagoons - Generally, PEI soils are too permeable to consider this option without the installation of a liner. Earthen lagoons are not as environmentally reliable due to the risk of puncturing the liner during cleanout. The liner must have a permeability rating of 10^{-7} cm/sec. Environmental approval will require certification by a qualified engineer. Soils must be tested to determine their permeability. Other suitable liners include bentonite and geotextile materials. The floor elevation of the storage must be 1 metre (3.3 ft) above the maximum water table and bedrock elevation.

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Safety

Safety design features and signage are especially important for liquid storages. They should include these measures:

- ***Safety Fences/Walls*** - a permanent safety fence or wall at least 1.5 metres (5 ft) in height should protect open liquid storages without fixed covers. This discourages access, particularly by children or livestock. Fences should be chain-link type.
- ***Concrete Liquid Manure Storage Covers*** - should be designed to support tractor loads if the tank cover is close to ground level. To avoid accidental access, the tank should be at least 0.6 metres (2 ft) above ground if the top is not designed for access.
- ***Locking Devices for Covers*** - should be used.
- ***Signage*** - all access points must be marked with suitable safety signs.

Farm operators should also observe the following safety practices:

- Never enter a liquid manure tank without a self-contained breathing apparatus coupled with a 3-person buddy system and a lifeline. The gases generated by liquid manure can be toxic and suffocating. Ventilation when agitating and pumping a manure tank is essential.
- Open flame should not be allowed near a liquid manure tank. The methane gas produced by liquid manure is highly explosive.

Curbed concrete manure storage with safety fence.

Planning Changes to Your Manure Handling and Storage System

Making a change in the way manure is handled is usually expensive because it often requires a fundamental change in the way many other things are done on the farm. When planning changes to your manure handling and storage system or constructing a new system, consider the following basic elements:

- storage capacity for *at least* 210 days
- safety concerns
- comparative cost of manure handling systems
- labour efficiencies
- the quality and adaptability of the current equipment
- requirements for new equipment
- flexibility in the system and location for future expansion
- moisture content of manure
- the location of the storage in relation to neighbours, streams, wells and groundwater
- the type of storage in relation to groundwater table and soil conditions
- method of collection and barn-to-storage transfer
- potential nutrient losses
- application method
- requirements to handle other liquids such as milkhouse washwater and bathroom wastewater
- preventing water pollution
- minimizing odours

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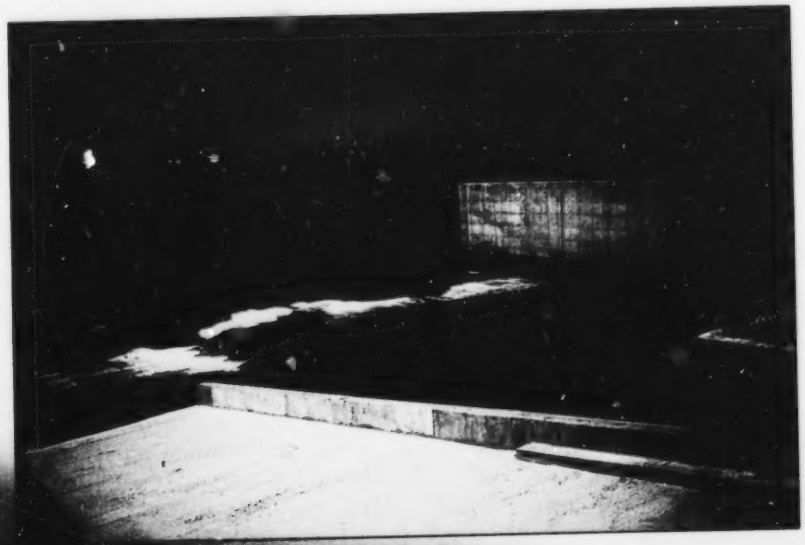

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- minimizing odours

Runoff Containment

Runoff management consists of two elements: decreasing the amount of water being contaminated by livestock operations and ensuring that contaminated runoff is contained so that it will not degrade the surrounding environment.

- Every effort to reduce the volume of runoff coming onto a livestock site will pay off in reduced storage size and costs. All runoff should be diverted away from livestock housing and manure storage areas. Perimeter diversion ditches, berms and dykes, and grassed or paved waterways can all be effective depending on the topography of the site.
- Roofed exercise yards will eliminate runoff.
- The use of eaves troughs on all roofs will allow roof drainage to be controlled and diverted.
- Contaminated runoff from manure storage and livestock areas must be contained and handled as part of the manure handling system. Runoff may be added to an existing liquid manure storage provided the storage has the capacity to handle the additional volume. Excess water in liquid manure storage does increase hauling and spreading costs. It also tends to hinder the formation of a surface crust, resulting in increased nitrogen losses and odour generation.
- Where solid manure systems are used, runoff must be handled separately. Runoff should be diverted to a separate liquid storage system. The required storage volumes will depend on local precipitation and the size and surfacing of the livestock area.
- Contaminated runoff can be treated in a constructed wetland.

Farm with urban encroachment.

Setback Considerations

Adequate separation between livestock facilities and neighbours is one means of compensating for normal odour production, reducing the potential for nuisance conflicts. Proximity to developments can determine the potential for future growth of the operation. Greater separation distances afford more opportunity for odours to become diluted by mixing with the air. When evaluating sites for **new operations only**, you must

select a location that will impact on as few neighbours as possible. Proposals for all new or expanded livestock operations are reviewed by the Department of Fisheries, Aquaculture and Environment.

The recommended minimum separation distance (MSD) between a livestock operation and a single residence or residential and recreational areas varies with the following factors:

- size of the agricultural operation measured in animal units
- degree of expansion from existing operation
- type of manure storage
- type of housing
- type of livestock

In general, larger separation distances are recommended as the size of the operation increases. Municipalities may require different siting criteria from those recommended here. The location of new operations must always be cleared with municipal authorities. Municipal property maps are very useful for evaluating new sites. For information on minimum separation distances, the reader should refer to "Guidelines for Manure Management for Prince Edward Island".

Required Minimum Separation Distance Between Manure Storage and Watercourses, Wetlands, and Wells

Storage Type	Distance to	
	Watercourse, or Wetland, m (ft)	Source of Domestic Water, m (ft)
On-Farm Storage Facility	90 (300)	90 (300)*
Field Storage	90 (300)	90 (300)*
Composting	90 (300)	90 (300)*

* public water supply 300 m (984 ft)

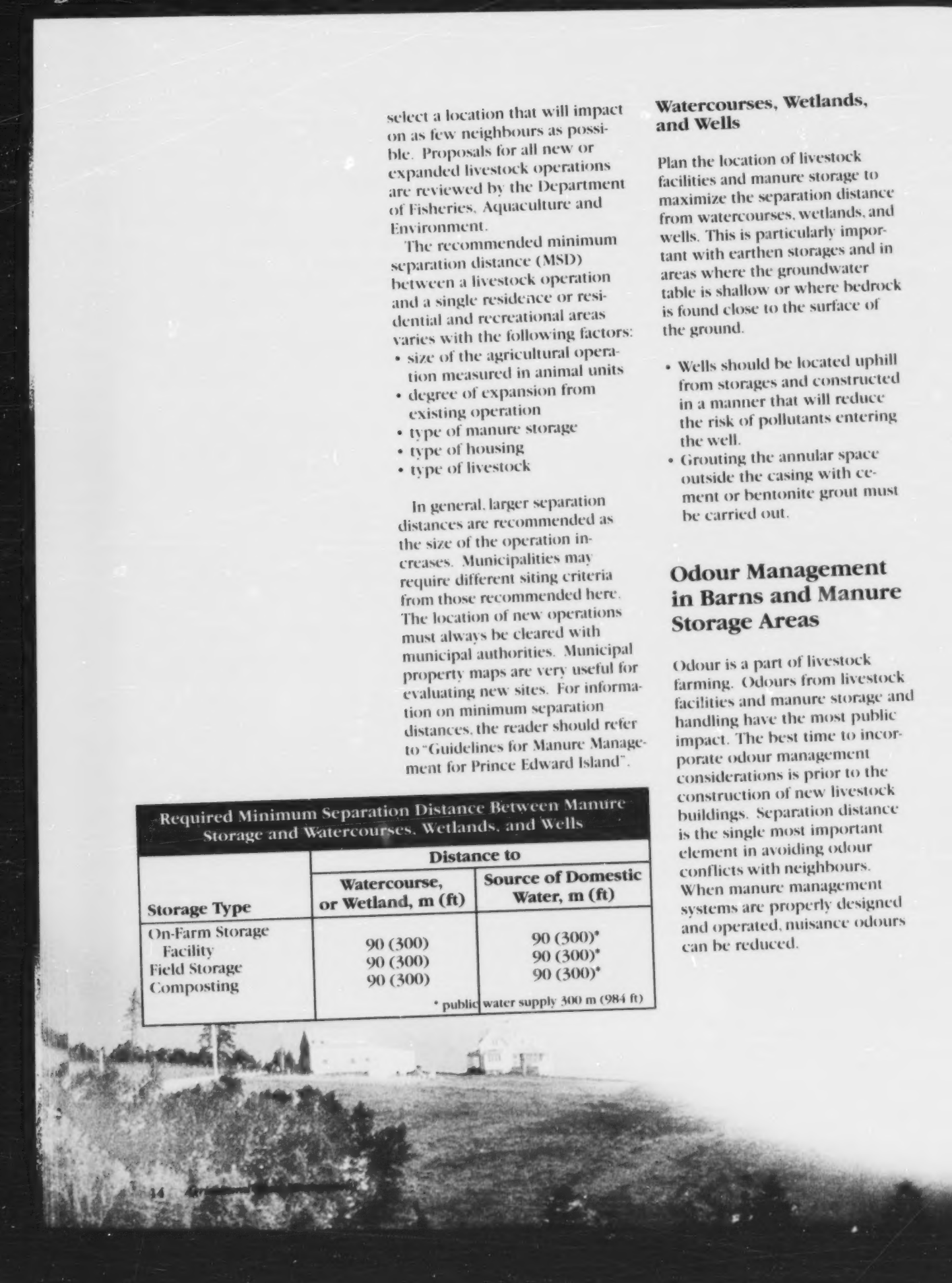
Watercourses, Wetlands, and Wells

Plan the location of livestock facilities and manure storage to maximize the separation distance from watercourses, wetlands, and wells. This is particularly important with earthen storages and in areas where the groundwater table is shallow or where bedrock is found close to the surface of the ground.

- Wells should be located uphill from storages and constructed in a manner that will reduce the risk of pollutants entering the well.
- Grouting the annular space outside the casing with cement or bentonite grout must be carried out.

Odour Management in Barns and Manure Storage Areas

Odour is a part of livestock farming. Odours from livestock facilities and manure storage and handling have the most public impact. The best time to incorporate odour management considerations is prior to the construction of new livestock buildings. Separation distance is the single most important element in avoiding odour conflicts with neighbours. When manure management systems are properly designed and operated, nuisance odours can be reduced.



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- type of livestock

In general, larger separation distances are recommended as the size of the operation increases. Municipalities may require different siting criteria from those recommended here. The location of new operations must always be cleared with municipal authorities. Municipal property maps are very useful for evaluating new sites. For information on minimum separation distances, the reader should refer to "Guidelines for Manure Management for Prince Edward Island".

Required Minimum Separation Distance Between Manure Storage and Watercourses, Wetlands, and Wells

Storage Type	Distance to	
	Watercourse, or Wetland, m (ft)	Source of Domestic Water, m (ft)
On-Farm Storage Facility	90 (300)	90 (300)*
Field Storage	90 (300)	90 (300)*
Composting	90 (300)	90 (300)*

* public water supply 300 m (984 ft)

Watercourses, Wetlands, and Wells

Plan the location of livestock facilities and manure storage to maximize the separation distance from watercourses, wetlands, and wells. This is particularly important with earthen storages and in areas where the groundwater table is shallow or where bedrock is found close to the surface of the ground.

- Wells should be located uphill from storages and constructed in a manner that will reduce the risk of pollutants entering the well.
- Grouting the annular space outside the casing with cement or bentonite grout must be carried out.

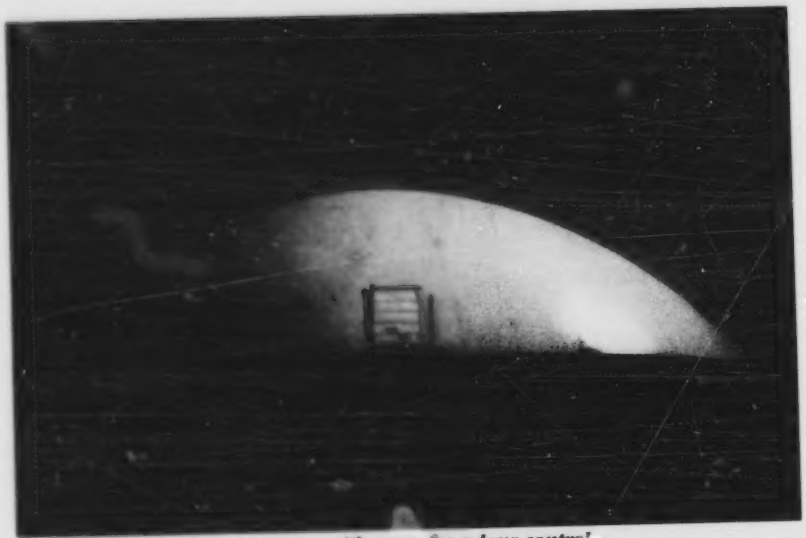
Odour Management in Barns and Manure Storage Areas

Odour is a part of livestock farming. Odours from livestock facilities and manure storage and handling have the most public impact. The best time to incorporate odour management considerations is prior to the construction of new livestock buildings. Separation distance is the single most important element in avoiding odour conflicts with neighbours. When manure management systems are properly designed and operated, nuisance odours can be reduced.

Distance from neighbours and non-agricultural land use will determine the level of technology and management required to minimize nuisance odours. The most common and effective odour control methods are based on ***reducing*** the amount of odour-causing gases produced and released to the atmosphere and ***dispersing*** odours as quickly as possible.

What Causes Odours

The biological breakdown of manure produces ammonia, hydrogen sulphide and other compounds such as mercaptans and amines. Combinations of these compounds can produce offensive odours at very small concentrations (parts per billion). The types of compounds produced depend on the biological processes which take place in the manure.



Concrete liquid manure storage, with cover for odour control.

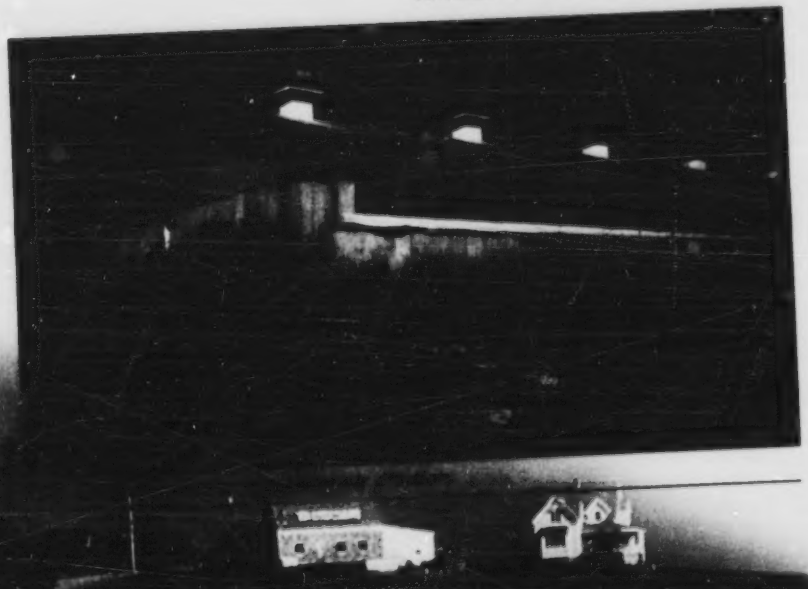
The following factors control these processes:

- Bacteria which are found in manure are responsible for creating odourous gases as they break down organic material. Aerobic bacteria, which require oxygen to survive, produce mostly carbon dioxide which is essentially odourless. Anaerobic bacteria, which thrive in the absence of oxygen, tend to produce odourous compounds such as ammonia and hydrogen sulphide. The type of bacteria present may vary at different locations throughout the manure handling system. Generally, aerobic bacteria are located near the surface, while anaerobic bacteria are beneath the surface.
- Temperature controls the rate of bacterial action. The higher the temperature, the faster the biological action and therefore the greater the gas production. This explains the fact that fewer odours are produced in cold weather conditions.
- Moisture is required for biological activity to take place. The bacterial activity slows and can be stopped as manure is dried. Moisture also makes anaerobic conditions more likely in the manure and thereby encourages the activity of odour-causing anaerobic bacteria.

- Type of waste material or manure affects the types and quantities of gases produced. For example, liquid poultry manure will produce more hydrogen sulphide than solid manure from broilers. Also, the addition of milkhouse wastes to manure storage can worsen the odour problem.
- Particle size or surface area also affects the rate of odour generation. The greater the surface area present, the faster the bacterial action proceeds.
- Chemicals may alter the process to reduce or increase the number and types of odours produced.

Often, odours are formed as the manure breaks down in storage, and remain trapped in the manure until they are released when the manure is agitated, moved, or spread.

The goal of odour management is to reduce the frequency, intensity, duration and offensiveness of odours and to manage the farm in a way that creates a positive attitude toward the operation.



BMPs for Odour Control in Livestock Facilities

- where storage is outside the facility, collect and transfer manure from the barn to storage on a daily basis
- ensure that sufficient bedding is added to absorb liquids with solid manure handling systems
- maintain water systems to prevent leakage
- use a pressure washer to clean buildings
- clean and disinfect buildings between successive groups of livestock
- keep dust levels low since odours are absorbed and carried in the air on dust particles; add moisture or oil to feed as a dust suppressant
- maintain recommended air flow through livestock buildings
- clean and maintain ventilation fans and shafts
- locate exhaust outlets for maximum air dilution; higher outlets generally provide greater dilution of exhaust gases
- locate exhaust outlets to take advantage of the prevailing winds; face them away from the nearest neighbour's residence if possible
- do not exceed recommended animal densities for livestock buildings

BMPs for Odour Control in Manure Storage

Most odour-causing gases are formed when manure is in storage. In practice, most manure storage is anaerobic. The anaerobic conditions promote odour production. These gases either escape from the storage to cause immediate problems or are released later during spreading.

Liquid versus solid. Typically fewer odours are produced by solid manure handling systems than by liquid systems. An undisturbed solid manure stack is self sealing so few odours are given off until the pile is disturbed. With open liquid storage, odours are common. Weather, as well as the addition of manure, can agitate the slurry-causing gases to be given off.

Covering a storage is an effective way to minimize odour generation. Storage covers:

- reduce occasional manure agitation caused by wind and rain; and
- reduce the movement of odourous air from storage areas to neighbouring residences.

When evaluating manure storage options, consider the following guidelines to reduce the potential for nuisance odours:

- Provide additional storage volume for greater flexibility in the timing of manure application. This can reduce the likelihood of storage overflow and permit application to coincide with the most appropriate timing and weather conditions.
- Separate the liquid and solid portions of manure in storage to reduce the promotion of anaerobic conditions.
- Avoid the addition of silage effluent and waste forage products to the manure storage reservoir. These combinations create strong odours.
- Discharge the inlet pipe below the liquid level to avoid surface agitation in a liquid storage system.
- Plant a buffer zone of trees or construct an earthen berm around the manure storage to reduce the movement of air over the manure surface. This has the added benefit of removing the storage from the sight of neighbours.
- Treatment technologies are available and can be used in rare cases when dealing with severe odour problems. Treatment systems must be designed to handle the manure volumes generated by the livestock operation.

Combination indoor/outdoor feedlot.

Feedlot Management

Feedlots are intensive operations where livestock are kept in a confined area and all food and water are delivered to the animals. The livestock can be either totally confined indoors, outdoors, or a combination of the two. Animal densities for outside lots will depend on whether the lot has a soil base or is hard surfaced.

Example of a Feedlot Area Runoff Control System

Site Selection

- Avoid sites with permeable soils and/or fractured bedrock. Groundwater contamination would be a high risk on these sites.
- Maintain recommended property setbacks from watercourses, wells, and neighbouring properties.
- Provide adequate lot slopes on outside lots for surface drainage.
- Allow for potential expansion.
- Prevailing wind direction should be taken into account in siting livestock facilities.
- Wind protection will enhance livestock performance.
- Ensure that upslope runoff is diverted away from the feedlot.

Solid Systems

Most confined livestock areas use a bedded pack. For well-bedded areas much of the liquid is absorbed, resulting in minimal seepage. Regardless of the amount of bedding, however, all seepage and runoff must be contained on the [illegible] property.

- A thorough cleaning of the feedlot once a year is recommended. Over cleaning will tend to remove the compacted and impervious soil and increase the possibility of downward nutrient movement.

Liquid Systems

Liquid systems use a slatted floor barn with no bedding. Liquid manure systems for beef operations are uncommon because of the associated high costs of the systems compared to other alternatives.

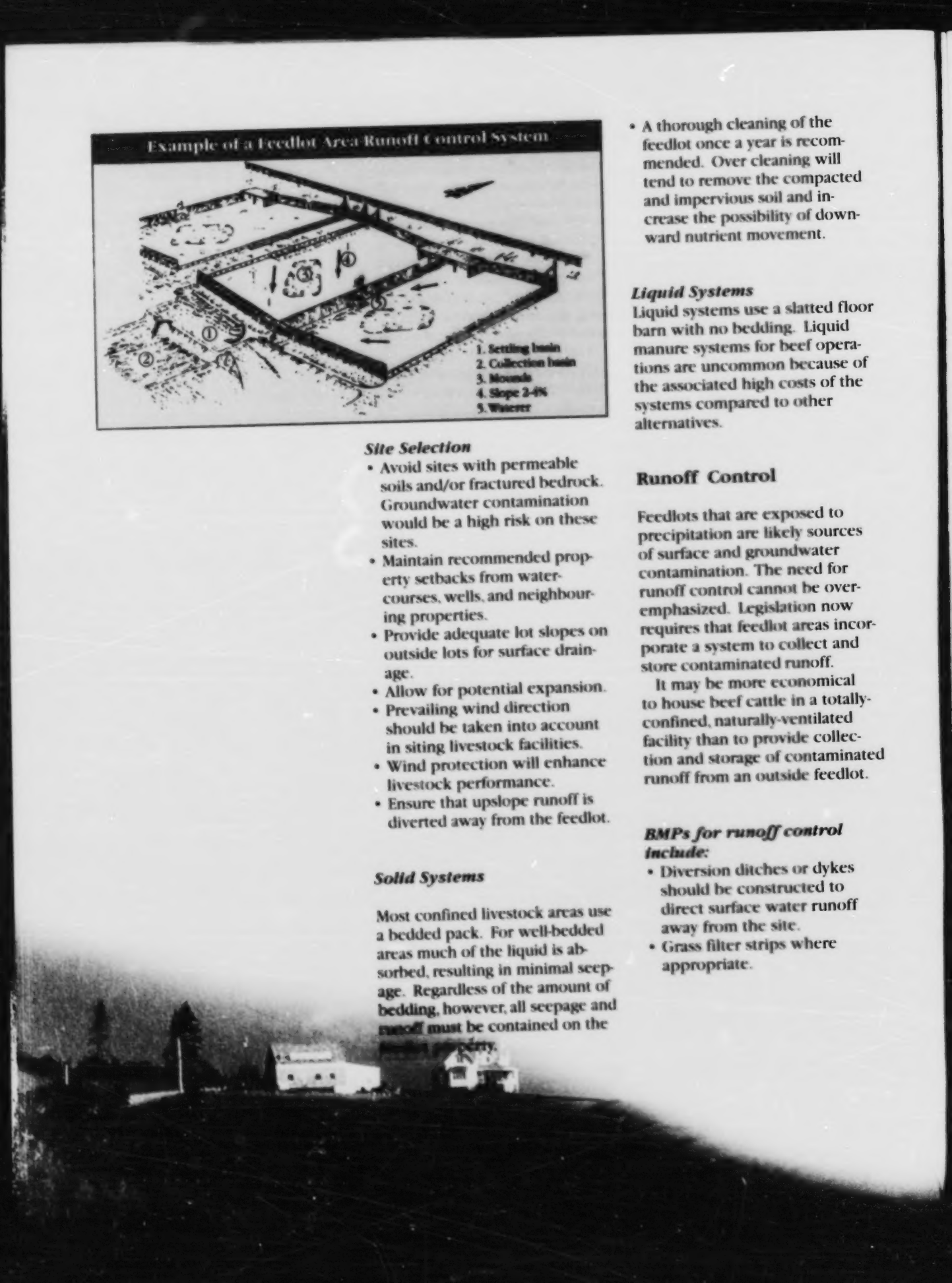
Runoff Control

Feedlots that are exposed to precipitation are likely sources of surface and groundwater contamination. The need for runoff control cannot be overemphasized. Legislation now requires that feedlot areas incorporate a system to collect and store contaminated runoff.

It may be more economical to house beef cattle in a totally-confined, naturally-ventilated facility than to provide collection and storage of contaminated runoff from an outside feedlot.

BMPs for runoff control include:

- Diversion ditches or dykes should be constructed to direct surface water runoff away from the site.
- Grass filter strips where appropriate.



Feedlot runoff will be easier to control if the feedlot yard is graded. This requires a 2-4% slope away from the feed area or shelter. Runoff from each yard should be directed to a collection basin or to the manure storage. The size of collection basins to store runoff from confined livestock areas depends on the size of the runoff area and the amount of precipitation. For PEI, allow $0.61 m^3/m^2$ (2 cubic feet per square foot) of surface area. Runoff control systems should be designed by an engineer. The volume of runoff can be reduced by limiting the size of the confinement area. Collected contaminated runoff can be either applied to the land or treated in a constructed wetland. *(See page 30.)*

Odour Management

Frequent cleaning and a high level of sanitation are the most effective ways of minimizing odours from feedlots. Key measures are:

- Keep the animals as clean and dry as possible. Wet manure on the warm body of an animal accelerates bacterial growth and increases odour.
- Scrape manure from the lot surface frequently. Drainage becomes less effective as manure accumulates.
- Provide well-bedded dry resting areas. This results in cleaner cattle, better overall sanitation and less odour from the lot area.
- To avoid continuous wetting of manure, prevent watering facilities from overflowing.
- Time the cleaning process in relation to seasonal weather conditions i.e. temperature, wind, etc.

Overall, maintain a neat appearance around the feedlot. Well-placed visual screens and shelterbelts ensure a positive public perception. For a more detailed discussion of odour management see page 14 (Odour Management in Barns and Manure Storage Areas).

Land Application

Spreading manure on land is a highly desirable method of recycling a natural, organic by-product of livestock production. A sustainable agricultural system should include manure as a fertilizer for crop production. Manure is readily available with a minimal input of energy and can significantly decrease crop production costs.

Most livestock operations are surrounded by large areas of productive agricultural land. To prevent damage to crops, minimize the risk of pollution and obtain the maximum benefit of the manure as a fertilizer, manure application rates should match the crop nutrient requirements. Too much of a good thing can lead to problems. Manure is an excellent fertilizer which poses an environmental risk only when mismanaged.

Animal manure can be a valuable soil amendment. When properly managed, it not only acts as a source of plant nutrients, but also helps improve soil tilth, structure, aeration and water-holding properties through the addition of organic matter.

Field application of solid manure.

To maximize the utilization of manure nutrients by crops:

- Have a sufficient land base for manure spreading.
- Test soil and manure to determine nutrient levels.
- Understand the release rates for nutrients in manure.
- Calculate crop nutrient demands.
- Prevent the loss of nutrients in surface runoff.
- Reduce the loss of nitrogen to the atmosphere.
- Minimize soil compaction and problems with soil structure.
- Prevent leaching of nitrates into groundwater.
- Prevent pollution of waterways by manure runoff.
- Minimize odours during spreading.

Application Rates

Manure application rates should be determined as part of an overall nutrient management plan. Do not try to provide all nutrients for a crop with manure. It is not likely that manure will release its nutrients at the right balance and time for your crop. Also, not all manure will have the right composition to meet crop requirements.

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- Test the macro-nutrient (nitrogen, phosphorus and potassium) content of your manure.
- Test the soil to determine nutrient levels.
- Know the nutrient needs of the crop being grown.
- Set a realistic target of providing up to 75% of the required nitrogen with manure. The balance would be provided by fertilizer. You need to know how much is applied in either case.

While the nitrogen requirement is the key factor in deciding the amount of manure to apply, phosphorus and other elements can also increase to excessive levels in fields where manure is applied every year.

An adequate land base is important to get the full benefits of manure. Long-term benefits increase if manure is spread over larger areas. Avoid yearly applications to the same land unless both a soil and manure test show there is no risk of reaching excessive nutrient levels.

The rate at which you can apply liquid manure will also be limited by the soil's ability to soak up the liquid before it runs off. Tillage before application may help if high rates are planned.

Manure Application Calendar

November to mid-April
- Manure should be going into storage, not on fields.
- Do not spread on frozen, bare, or snow-covered land.

Mid-April to mid-June
- Apply to land growing annual crops before planting.

Mid-June to August
- Inject liquid manure between rows of growing row crops.
- Apply manure to cereal land immediately after harvest and prior to conservation tillage.

September to October
- Apply manure to grassland. Avoid applications in areas subject to concentrated runoff and avoid tillage until after October 15.
- Apply to annual crop lands that will be planted with winter cover crops.

Spreading Considerations

- Manure should be incorporated into the soil as soon as possible after spreading. This will minimize the potential for odour complaints and pollution from runoff and will ensure that maximum fertilizer benefits are gained from the manure. It is recommended that surface applied manure be incorporated within 24 hours of application.
- Injecting liquid manure directly into most soils is the best practice if it can be done before preparing the seed bed or during the cropping season. Nutrients are readily available to growing plants.
- To avoid soil compaction problems, do not apply manure under wet soil conditions.
- Manure must not be discharged or allowed to enter any watercourse.
- Manure should not be spread within 30 metres (100 ft) of a watercourse on slopes less than 5% and within 60 metres (200 ft) of a watercourse on slopes greater than 5%.

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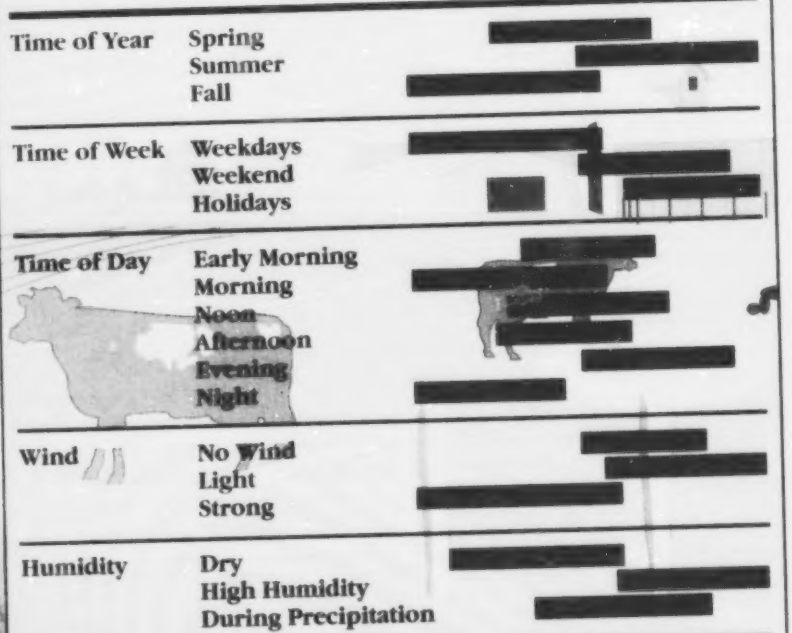
Timing Considerations

It is usually best to apply manure before, or early in, the growth stage of any crop. Some forms of nitrogen are available immediately to plants. In addition, nutrients in organic form may be released throughout the growing season. If manure is spread late in the growing period or after the growing season, there is reduced benefit to the crop, and there is an increased risk of nitrate leaching to groundwater or surface runoff contaminating watercourses.

RELATIVE LIKELIHOOD OF ODOURS BEING OFFENSIVE DUE TO TIME OF MANURE APPLICATION*

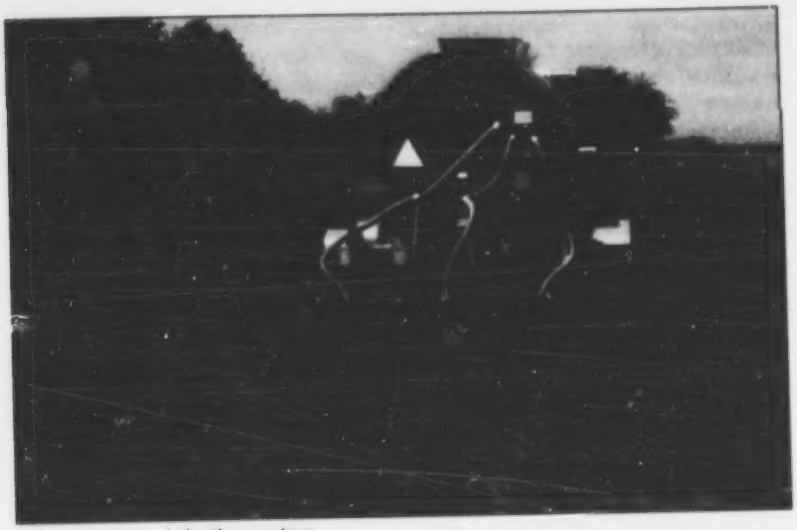


From Odour Control Guidelines for Livestock Operators, P. Jacobs & Associates Ltd., 1994.
* Based on various studies and on personal observations of the authors.

Odour Management

Manure spreading is the most common cause of nuisance odour. There are many factors that contribute to the production of odours during application. The following management practices are the best method of minimizing the possibility of complaints:

- Keep transport equipment clean and well maintained to ensure that manure is not deposited on public roads. Do not overload equipment. If a spill occurs, clean the road promptly.
- Avoid transporting manure on public roads during periods of high traffic such as rush hours before and after work, or during lunch break.
- Check the weather conditions before spreading. The best weather for spreading is sunny days with windy, cloudy nights. Sunshine will dry the manure quickly, preventing further odour production. Turbulent air movement dilutes odours. Rain removes odours from the air. However, the worst conditions are damp, humid weather with light winds. Still air keeps the gases in the area and moist conditions allow for more odour production.
- Spread in the morning when air is warming and rising, rather than late in the afternoon.
- Consider when possible the implications of spreading on holidays and weekends when neighbours are most likely to be affected by odours.
- Notifying neighbours prior to spreading on adjacent properties is a "good neighbour" policy.



Liquid manure injection system.

- Do not exceed recommended rates of application for your soil type. Generally, the worst period for odours is during the first 12 to 48 hours after spreading. With very heavy application rates, odours could last up to 10 days.
- Incorporate manure into the soil as soon as possible after application. Spread and till methods reduce the release of odours. Injection of manure directly into the soil is an excellent method of odour control. With injection, odours are less detectable at 70 metres (230 ft) than they are at 400 metres (1,300 ft) from surface applied manure.
- Apply composted manure to pastures and hay fields. Where this is not possible, apply manure in a very thin layer so that it will dry in five days or less. This will also prevent fly propagation.
- Keep the discharge height of the slurry as low as possible to reduce odours during land application.
- Choose discharge methods that are most effective for odour control. From most to least effective are:
  - Dribble bars or booms
  - Bottom discharge tanker
  - Top discharge tanker

Manure Treatment

Treatment of manure is designed to reduce the pollution potential, make handling easier and/or increase the value of manure. Treatment can be either physical, biological or chemical.

Physical treatments such as separation of solids from liquids are usually considered primary treatment.

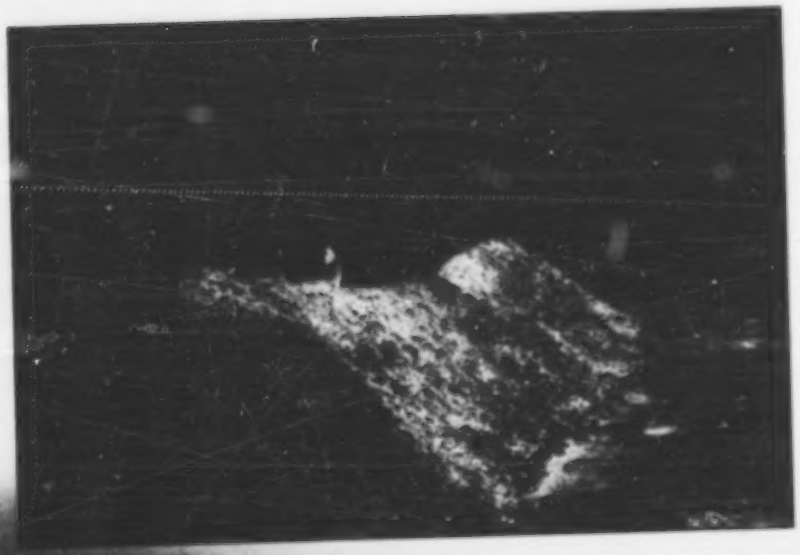
Biological treatment methods are usually categorized as either anaerobic or aerobic to describe the type of bacteria that are encouraged to break down the solids in the manure. Composting, naturally aerated lagoons, oxidation ponds, mechanical agitation

or pumping and air injection are examples of aerobic treatment methods. Anaerobic methods include anaerobic ponds and digesters.

Many of these treatment systems have not been totally successful in on-farm applications. Either the treated wastes would still pollute the environment, or the systems are too costly to be economically feasible. Producers should give serious consideration to the economic and social benefits derived from treatment technologies before investing. As technologies continue to be developed, a suitable system may be found.

On-Farm Composting of Manure

Composting is the aerobic decomposition of organic materials by microorganisms under controlled conditions. During decomposition, the microorganisms consume oxygen while feeding on organic matter. Composting reduces both the volume and mass of the raw materials while transforming them into a valuable soil conditioner.



The Benefits of Compost:

- compost adds organic matter, improves soil structure, reduces fertilizer requirements and reduces the potential for soil erosion.
- composting involves an increase in expenditure, however the increased market potential and soil conditioning properties offer benefits.
- markets for compost are readily available. Potential buyers include home gardeners, landscapers, vegetable farmers, operators of golf courses, etc.
- composting reduces the weight and moisture content and increases stability of manure. Compost is easier to handle than manure and stores well without odours or fly problems, thus lowering the risk of pollution and nuisance complaints.
- composted manure is less susceptible to leaching and further ammonia losses. Composting high-carbon manure/bedding mixtures lowers the carbon/nitrogen ratio to acceptable levels for land application.
- proper temperatures within the compost pile will reduce pathogens.
- potential reduction in soil-borne plant diseases.

Composting systems used on farms:

Passive composting - involves simply stacking the materials in piles to decompose over a long period of time with little agitation and management.

Windrow composting - the materials are formed into long narrow windrows which are mechanically turned.

Aerated static pile - the most common approach, uses blowers to force air though pipes and into the pile.

In-vessel composting - the materials are contained within bins, reactors, or buildings where a high level of control of moisture and oxygen is provided.

In terms of cost, labour, management and process speed, the windrow and aerated static pile systems are comparable. In-vessel composting is generally more expensive but results in better control over the process, a higher quality product, and less odour.

The location of a composting site should provide:

- easy access with a minimum of travel and materials handling.
- a firm surface to support vehicles under varying weather conditions.
- appropriate separation distance from wells, watercourses and neighbours.
- minimal risk of groundwater contamination.
- good surface drainage.
- grading for containment of surface runoff.

Compost applications to land should be based on soil test results and crop needs. This is to prevent a nutrient imbalance from occurring and to make efficient use of compost.

Fly Control

Flies near livestock and poultry facilities and manure storage areas are a nuisance to farm operators and neighbours. Flies may also transmit disease from one farm to another. A successful fly control program can involve:

- regular removal of manure and wet feed from the building: at least once every seven days during the fly breeding season to break the reproduction cycle
- avoiding the scattering of manure and feed outside the building during barn cleaning operations
- keeping the manure collection area dark
- providing screens on all openings in buildings
- keeping the manure in enclosed structures if possible
- prompt disposal of dead animals and afterbirth
- regular cleaning and disinfection
- use of biological controls i.e. parasitic wasps

In situations where these management options are not sufficient to control the problem, spraying with insecticides may have to be considered.

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Milkhouse Waste

Handling milkhouse wastewater has become increasingly important as dairy operations become larger and more automated. Quantities and strength of wastewater from milking parlours vary from farm to farm.

Modern milking parlours and pipeline milking systems utilize large quantities of water. The volume of water used depends on:

- the management practices associated with the milking facility;
- the type of milking system;
- the bulk tank system;
- the floor wash down;
- other uses ie. udder wash, water conditioners, etc.

The average daily production of washwater on a per milking cow basis is 14.1 litres (3.1 gallons).

The disposal of this washwater has become a major environmental concern.

Wastewater contains milk solids, fat, detergents, acid cleaners and sanitizers, manure, soil particles, and other substances.

Washing Operation	Washwater Produced Litres (Imp. Gallons)
Bulk Tank	
Automatic	150-225 *l* (33-50 gal)/wash
Manual	115-150 *l* (25-33 gal)/wash
Pipeline[a] (in parlour)	285-475 *l* (63-104 gal)/wash
Bucket Milkers	115-150 *l* (25-33 gal)/wash
Miscellaneous Equipment	115 *l* (25 gal)/day
Cow Prep	
Automatic	4-17 *l* (0.8-3.75 gal)/cow
Manual	1-2 *l* (0.2-0.4 gal)/cow
Milkhouse Floor	38-76 *l* (8-16 gal)/day
Parlour Floor Without Flushing	150-285 *l* (33-62 gal)/day
Parlour and Holding Area Floor with Flushing	
Parlour Only	75-114 *l* (17-25 gal)/cow/day
Parlour and Holding Area	95-150 *l* (21-33 gal)/cow/day
Holding Area Only	38-76 *l* (8-16 gal)/cow/day

a. Volume increases for long lines in large stanchion barns

Source: Midwest Plan Service, 1995.

Environmental Concerns

The following table shows typical waste strengths for milkhouse washwater.

Milking Centre Washwater	
Parameter	Concentration (mg/l)
Total Solids	1417-3506
Suspended Solids	171-996
Oil and Grease	5-330
Biochemical Oxygen Demand	207-1530
Chemical Oxygen Demand	542-4554
Total Phosphorus	35-288
Total Nitrogen	14.9-37.4*

*Source: Urgel Delisle (1990), except for * = B.C. Farm, Lo, K.V. et al., 1988.*

Notes:

TOTAL SOLIDS includes all solid materials either dissolved or suspended in the washwater.

SUSPENDED SOLIDS refers to the amount of material suspended in the washwater which could be removed by filtration. The level of suspended solids in milking centre washwater gives a good indication of the clogging potential of the material in underground infiltration systems.

OIL AND GREASE originate from the biodegradable fats and oils in milk. High levels of oil and grease will result in considerably larger scum and sludge accumulations in septic tanks containing milking centre washwater. Oil and grease that moves into the leaching bed can clog and seal tile lines as well as the trenches, often resulting in complete failure of the bed system.

BIOCHEMICAL OXYGEN DEMAND (BOD) is a measure of organic waste strength and is usually reported as the amount of oxygen consumed over a specified period of time. High BOD loading can depress the dissolved oxygen concentrations in receiving waters to levels that affect aquatic organisms. High BOD levels in milking centre washwater are an indicator of high organic levels as a result of milk, manure, etc., present in the waste product.

CHEMICAL OXYGEN DEMAND (COD) is a measure of the amount of oxygen required to chemically oxidize the organic matter in the washwater. Like BOD, COD is an estimation of the amount of organic material present.

TOTAL PHOSPHORUS includes soluble phosphate generally in the form of PO_4 and organic bound P (phosphorus bound to soil). Soluble phosphate can be released and is readily available for algal growth. Phosphorus originates predominantly from the detergents and phosphoric acid used in the wash cycles during the cleaning of the milking system.

TOTAL NITROGEN includes organic and inorganic nitrogen and ammonia. Ammonia is the major nitrogen parameter of concern due to its toxicity for fish and other aquatic animals. In treatment trench systems, nitrogen is normally converted to nitrate (NO_3) which can contaminate groundwater. Nitrogen originates from manure or nitrogen based detergents.

Best Management Practices

Proper milkhouse washwater management should consider options for reduction and reuse.

Reduce

- Manual washing and prepping of cows uses less water than automated systems.
- Mechanically removing manure and wasted feed from the parlour prior to wash down reduces waste volume and strength.
- Manually check water hardness and iron content, and calibrate cleaning equipment annually. Adjust chemical cleanser concentrations based on the quality of the washwater.
- Design the milking parlour to minimize washwater requirements. Drain locations and floor slopes are important.

Reuse

- Feed the first rinse of milking equipment to calves. This will reduce the amount of milking centre washwater by 15-20%.
- Feed pre-cooler water to livestock. Pre-coolers are used to lower milk temperature before it enters the bulk tank.
- Many new dairy operations have underground tanks to store washwater. Use this water to wash parlour floors and drain to manure storage.
- Recycling washwater reduces the amount of chemical cleansers required. Washwater can be used from one cleaning cycle to the next.
- Make sure the reused water does not

Milkhouse Waste

Handling milkhouse wastewater has become increasingly important as dairy operations become larger and more automated. Quantities and strength of wastewater from milking parlours vary from farm to farm.

Modern milking parlours and pipeline milking systems utilize large quantities of water. The volume of water used depends on:

- the management practices associated with the milking facility;
- the type of milking system;
- the bulk tank system;
- the floor wash down;
- other uses ie. udder wash, water conditioners, etc.

The average daily production of washwater on a per milking cow basis is 14.1 litres (3.1 gallons).

The disposal of this washwater has become a major environmental concern.

Wastewater contains milk solids, fat, detergents, acid cleaners and sanitizers, manure, soil particles, and other substances.

Washing Operation	Washwater Produced Litres (Imp. Gallons)
Bulk Tank	
Automatic	190-225 *l* (42-50 gal)/wash
Manual	115-150 *l* (25-33 gal)/wash
Pipeline[a] (in parlour)	285-475 *l* (62-104 gal)/wash
Bucket Milkers	115-150 *l* (25-33 gal)/wash
Miscellaneous Equipment	115 *l* (25 gal)/day
Cow Prep	
Automatic	4-17 *l* (0.8-3.75 gal)/cow
Manual	1-2 *l* (0.2-0.4 gal)/cow
Milkhouse Floor	38-76 *l* (8-16 gal)/day
Parlour Floor Without Flushing	150-285 *l* (33-62 gal)/day
Parlour and Holding Area Floor with Flushing	
Parlour Only	75-114 *l* (17-25 gal)/cow/day
Parlour and Holding Area	95-150 *l* (21-33 gal)/cow/day
Holding Area Only	38-76 *l* (8-16 gal)/cow/day

a. Volume increases for long lines in large stanchion barns
Source: Midwest Plan Service, 1995.

Environmental Concerns

The following table shows typical waste strengths for milkhouse washwater.

Milking Centre Washwater	
Parameter	Concentration (mg/l)
Total Solids	1417-3506
Suspended Solids	171-996
Oil and Grease	5-330
Biochemical Oxygen Demand	207-1530
Chemical Oxygen Demand	542-4554
Total Phosphorus	35-288
Total Nitrogen	14.9-37.4*

*Source: Urgel Delisle (1990), except for * = B.C. Farm, Lo, K.V. et al., 1988.*

***Notes:**

TOTAL SOLIDS includes all solid materials either dissolved or suspended in the washwater.

SUSPENDED SOLIDS refers to the amount of material suspended in the washwater which could be removed by filtration. The level of suspended solids in milking centre washwater gives a good indication of the clogging potential of the material in underground infiltration systems.

OIL AND GREASE originate from the biodegradable fats and oils in milk. High levels of oil and grease will result in considerably larger scum and sludge accumulations in septic tanks containing milking centre washwater. Oil and grease that moves into the leaching bed can clog and seal tile lines as well as the trenches, often resulting in complete failure of the bed system.

BIOCHEMICAL OXYGEN DEMAND (BOD) is a measure of organic waste strength and is usually reported as the amount of oxygen consumed over a specified period of time. High BOD loading can depress the dissolved oxygen concentrations in receiving waters to levels that affect aquatic organisms. High BOD levels in milking centre washwater are an indicator of high organic levels as a result of milk, manure, etc., present in the waste product.

CHEMICAL OXYGEN DEMAND (COD) is a measure of the amount of oxygen required to chemically oxidize the organic matter in the washwater. Like BOD, COD is an estimation of the amount of organic material present.

TOTAL PHOSPHORUS includes soluble phosphate generally in the form of PO_4 and organic bound P (phosphorus bound to soil). Soluble phosphate can be released and is readily available for algal growth. Phosphorus originates predominantly from the detergents and phosphoric acid used in the wash cycles during the cleaning of the milking system.

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Best Management Practices

Proper milkhouse washwater management should consider options for reduction and reuse.

Reduce

- Manual washing and prepping of cows uses less water than automated systems.
- Mechanically removing manure and wasted feed from the parlour prior to wash down reduces waste volume and strength.
- Manually check water hardness and iron content, and calibrate cleaning equipment annually. Adjust chemical cleanser concentrations based on the quality of the washwater.
- Design the milking parlour to minimize washwater requirements. Drain locations and floor slopes are important.

Reuse

- Feed the first rinse of milking equipment to calves. This will reduce the amount of milking centre washwater by 15-20%.
- Feed pre-cooler water to livestock. Pre-coolers are used to lower milk temperature before it enters the bulk tank.
- Many new dairy operations have underground tanks to store washwater. Use this water to wash parlour floors and drain to manure storage.
- Recycling washwater reduces the amount of chemical cleansers required. Washwater can be used from one cleaning cycle to the next.
- Make sure that reused water does not increase bacterial counts.

Handling and Treatment Options

Regardless of the disposal system used, it must be properly designed, installed and operated.

To select and design the best system for your farm, you need to know your approximate daily washwater production. Measure your actual water use by installing a water flow meter, or estimate it using a calibrated pail.

Liquid Manure Storage

Farms equipped to handle liquid manure can divert milkhouse effluent to the liquid manure storage. The combined milkhouse waste and manure is eventually applied to the land with liquid manure following proper manure management guidelines.

Advantages

- an existing storage with adequate capacity can be utilized to store milkhouse waste;
- better agitation can be achieved through the extra volume of liquid milkhouse waste making it easier to pump to a spreader;
- storage can be sized to handle the additional wastewater;
- best option if washwater contains the first rinse and/or has a high solids content.

Disadvantages

- lowers fertility value of manure;
- requires up to 25% increase in manure storage capacity;
- the increased volume must be spread on fields, adding to handling costs.

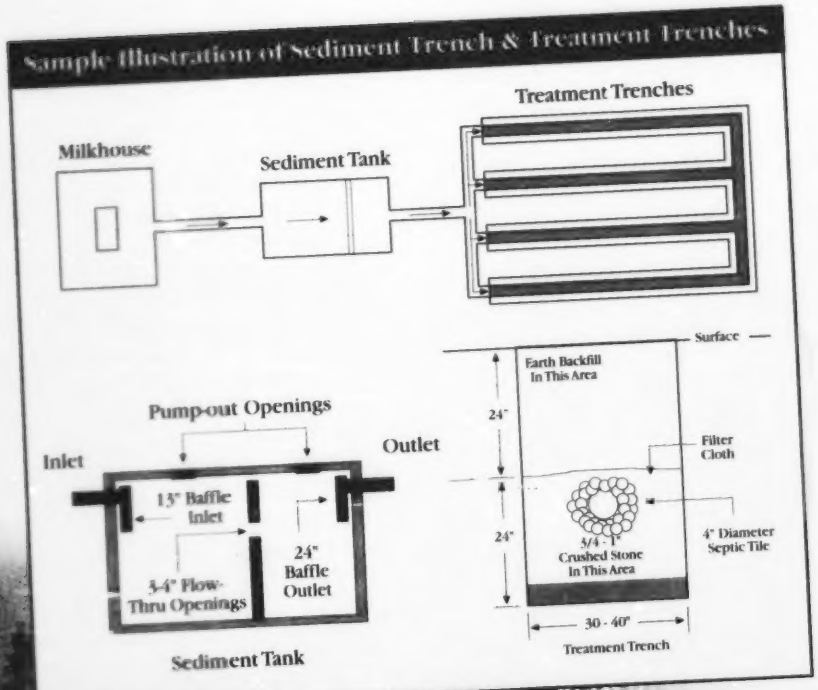
Settling Tank and In Ground Disposal Field

This system is similar to a household septic system but instead handles the wastewater for the milking centre. It also requires proper site conditions. If the soil is too shallow to bedrock, has low permeability or a high water table, another management system may be required. This system requires careful design installation and management to ensure long-term success.

Advantages

- does not impact the capacity of manure storage and handling systems;
- relatively low cost.

Sample Illustration of Sediment Trench & Treatment Trenches



Disadvantages

- first rinse, milk from treated cows or colostrum must be diverted from the system;
- does not work in areas with low permeability or high water tables;
- requires careful management and maintenance;
- sludge levels within the tank should be checked and removed as required.

Conventional in ground disposal fields have been used extensively in the past and with proper design, management and soil conditions, these systems can work quite well.

Historically, many systems have failed due to the disposal of excessively high strength milkhouse washwater through the system.

You may consider this system if:

- you do not have or are not planning to build a liquid manure or runoff storage;
- the soil has good drainage characteristics;
- your washwater is relatively free from solids;
- you are willing to restrict the water that enters the system to a minimum;
- you are willing to collect the first rinse from the milking equipment;
- you are willing to prevent milk from going down the floor drain.

To prevent whole milk from reaching the disposal field system, it is recommended that a double compartment septic tank with proper baffles on the inlet and outlet pipes and a storage capacity for several days of milkhouse effluent be installed. Allowing the milk several days residence in the tank will allow most of the milk fats to separate and form a layer at the top of the tank which must be periodically pumped. A minimum retention time of four days is recommended, but six days is preferred.

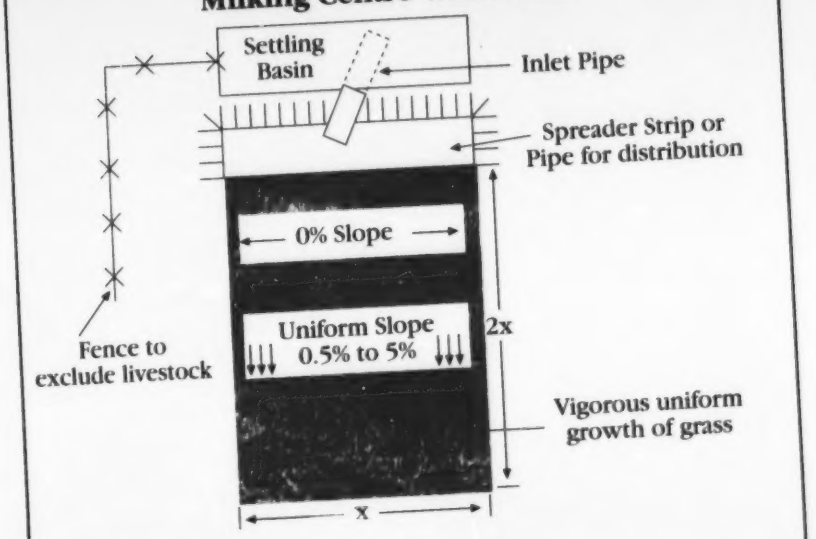
Research and experience have shown that constructing the disposal fields to promote aerobic conditions for a period of time between milkings will greatly improve the reliability and useful life of these systems. This will allow microbial activity to oxidize some of these materials and prevent trench sealing.

Vegetative filter strip bed.

Vegetative Filter Strip Bed

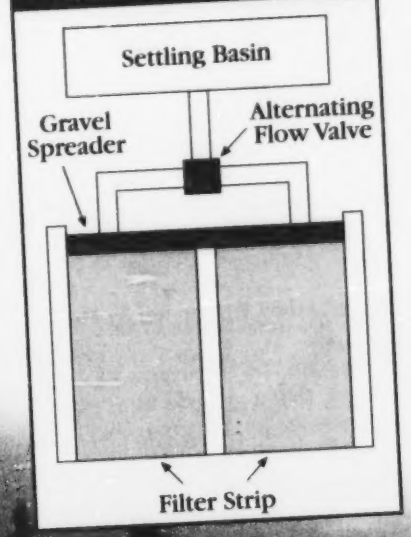
Testing in the Maritimes has shown that a grassed filter strip can also be an effective and economical milkhouse wastewater treatment alternative. As the wastewater flows down a filter [illegible] evaporates

Grass Filter Bed (Top View)



Minimum Area
Filter Strip Size - 164 square metres per cubic metre (50 sq ft per cubic foot) of wastewater. Length should be equal to twice the width.

Schematic of Vegetated Filter Strip



soil and plant media filter out and biodegrade the fine solids and organic material. Nitrogen and phosphorus are taken up by the plant life and absorbed to soil particles.

The design of an effective filter strip includes a settling basin ahead of the filter strip, a spreading device at the entrance of the filter strip to ensure even flow across the strip and provisions to alternately apply wastewater to two parallel strips. This will allow the filter strip a rest period during which no wastewater is applied.

Advantages
- does not impact upon existing manure storage or handling;
- relatively low cost.

Disadvantages
- first rinse, milk from treated cows or colostrum must be diverted from the system;
- requires careful management and maintenance;
- solids must be removed regularly from the settling basin to prevent overflow to the grass filter strip;
- may not provide optimal treatment during the winter months.

Constructed Wetlands

Constructed wetlands are shallow, man-made aquatic systems that can provide an environment for treating agricultural runoff and wastewater. Constructed wetlands have been utilized as treatment systems for a number of wastewater sources including:

- milkhouse washwater;
- manure storage and feedlot runoff;
- drainage tile outflow;
- agricultural field surface runoff; and
- food processing wastewater.

Constructed wetlands utilize a series of physical, biological and chemical processes which facilitate the treatment of wastewater.

Wetlands have been constructed on agricultural operations throughout Atlantic Canada and many have been extensively monitored. The concentration of

Constructed wetland.

waste-water pollutants including suspended solids, nitrogen, phosphorous and faecal coliforms, as well as BOD and COD levels, have been reduced by 70-98 %.

Design Considerations

- Before construction, hire a qualified engineer to design the wetland and obtain required building and environmental permits from the PEI Department of Fisheries, Aquaculture and Environment.
- Constructed wetlands should only be designed as secondary or tertiary wastewater treatment systems. The size of a wetland must be based on the inflow volume, the concentration of pollutants in the wastewater, and the desired level of treatment.
- Site selection is important. The wetland will be more economical to construct if it is located close to the wastewater source and if the wastewater can flow by gravity to the wetland.
- Perform soil permeability tests early in the planning stage. If the hydraulic conductivity is greater than $1x10^{-5}$ cm sec^{-1}, a clay or synthetic liner will be required. This will greatly add to the cost of the wetland and may be a reason to consider other options.
- Many agricultural wastewater sources produce small volumes of effluent. During the summer, evaporation rates from the wetland are often higher than inflow volumes. Additional water from other sources such as roof gutters may have to be added to the system.
- Wastewater must be retained in a settling pond prior to entering the wetland to allow for adequate separation of solids. This pond should be less than 1 metre (3 ft) deep to reduce odour potential.
- Wetlands are more efficient during summer months. It may be desirable to design the settling pond to be large enough to store the entire volume of wastewater produced during the winter and to discharge it to the wetland during the summer.
- The proposed site must be surveyed to produce an accurate topographical map.

- Constructed wetlands may contain one cell or several individual cells depending upon the topography. If the construction site is on a slope, it may be desirable to construct individual cells in a terrace type system. The length of each cell should be twice the width. The topography should be relatively level over the entire cell to ensure an even depth of water. Individual wetland cells should include both deep and shallow zones. Shallow zones should have water depths ranging between 15-30 cm (6-12 in). Deep zones help to evenly distribute water and add to the retention time as wastewater passes through the wetland. Deep zones should constitute 25% of the surface area and they should be at least 1 metre (3 ft) deep to prevent growth of aquatic plants.
- The outflow from a constructed wetland should receive final polishing by discharging it to a tertiary pond or grassed waterway.
- Aquatic vegetation (cattails and bulrushes) is best established by transplanting root stock from a nearby natural wetland. The roots should be planted at a density of at least one plant per square metre (10 sq. ft). A permit is required from the PEI Department of Fisheries, Aquaculture and Environment to remove cattails from existing wetlands.

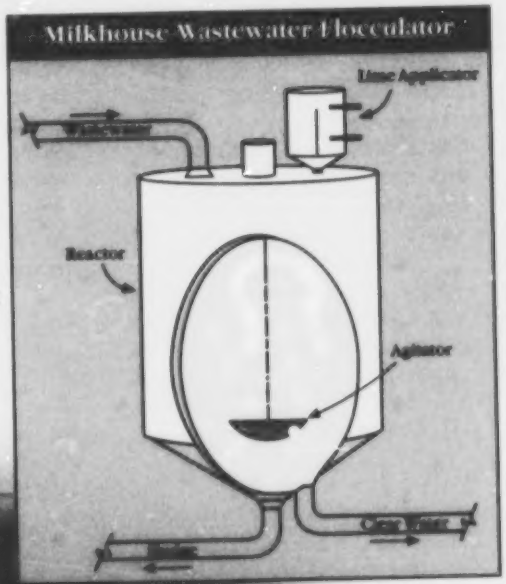
Management to achieve maximum performance of the wetland may include:

- Eventual removal of solids from the pre-treatment settling pond.
- Possible addition of water to the wetland during prolonged dry periods to prevent stress of aquatic vegetation and cracking of a clay liner.
- Eventual excavation of sediment and plant material from the wetland cell if there is an accumulation of phosphorous.
- Control of muskrat populations.

Flocculator

Another innovative new technology recently introduced to the Maritimes involves the use of chemical treatment reactors or flocculators to remove the majority of phosphates and suspended solids from the milkhouse effluent.

The effluent is transferred from the milkhouse to a reactor and a proportionate amount of hydrated lime is added to the reactor. The mixture is allowed to settle undisturbed for two hours. Then the clarified liquid is discharged to the disposal field system while the sludge is sent to the manure storage. This technology is relatively new and its cost efficiency for treatment of milkhouse waste requires more evaluation.



Livestock Pasturing

The pasturing of cattle is a common practice on most PEI dairy and beef farms. Traditionally, it was desirable to have a pasture that had a watercourse running through it to allow for convenient watering of livestock. However, more recently it has become the recommended practice to restrict livestock from having access to watercourses because of their impact on water quality and the damage that they cause to the riparian zone. It has also been found that cattle are healthier and more productive if they are provided with a fresh source of water. Many farmers have fenced livestock out of streams and have implemented practical watering alternatives. This has proven beneficial to both the health of the cattle and the environment.

Health and Productivity Concerns

Supplying abundant quantities of fresh, clean drinking water is critical for good health and maximum productivity of cattle. Cattle that have direct access to watercourses, for drinking purposes, can experience the following problems:

- Decreased water consumption resulting in reduced productivity. Cattle are less likely to drink sufficient quantities of water if it has been contaminated by their access to the watercourse.
- Reduced productivity due to lost grazing time. Cattle enjoy loafing in streams and they will not be productive if they are not foraging. If a stream is the only watering source, cattle may have to spend excessive time travelling to obtain water because streams are often not strategically located in the pasture.
- Increased risk of disease transmissions. Cattle can contract Leptospirosis, Salmonella, Bovine Virus and algae poisoning, especially if the water is slow moving or stagnant.
- Increased udder problems from mud and dirt buildup. Calves have more difficulty nursing and mastitis is more prevalent.
- Increased stress to feet and legs if animals have access to steep [illegible] stream

Fencing protects sensitive habitat areas.

Impact on Watercourses

If cattle have access to watercourses, including springs, ponds, streams, wetlands and estuaries, the following impacts can be observed:

- Unstable stream banks due to loss of vegetation.
- Widening of watercourses and reduced stream velocities due to the hoof action of livestock.
- An increase in water temperatures as shade cover is destroyed.
- A reduction in the ability of the area surrounding the watercourse to filter and absorb contaminants (ie nitrates, faecal bacteria, etc.) which may be contained in surface runoff.
- A reduction in the quality of fish and wildlife habitat.
- An increase in faecal bacteria contamination and nutrient loading in the watercourse. This can result in shellfish closures and restricted use for recreational purposes.

Best Management Practices

To reduce the impact that pasturing livestock have on a watercourse, the following practices are recommended:

- Restrict livestock access by fencing off streams, wetlands, ponds and marshes and provide livestock with an alternate source of water. The wider the buffer between the fence and the stream, the better the filtering capacity of the riparian zone.
- Provide stream bank protection in highly disturbed areas to prevent further erosion. Use vegetative measures where possible. Rock riprap underlain with a suitable geotextile is also an option.
- Manage pastures to reduce the concentration of manure and maintain permanent forage cover. Vigorous forage growth on pastures protects soils and minimizes runoff. Avoid heavy traffic areas by increasing the number of in-pasture watering locations.
- In cases where pastures exist on either side of a watercourse, a livestock stream crossing should be constructed and maintained. The crossing should have fences on both sides. Culverts or wood structured bridges provide good crossings. Costs can be kept to a minimum if the crossing does not have to support farm equipment.

A Watercourse/Wetland Alteration Permit is required from the PEI Department of Fisheries, Aquaculture and Environment if any excavation is required within 10 metres (33 ft) of a watercourse or if a stream crossing is being installed.

Stock tanks provide a convenient, reliable source of water.

Alternate Watering Systems

On PEI, the following alternate watering systems have been utilized by farmers to water cattle:

Farm wells

- Most flexible, reliable and cost efficient source of water.
- Water can be pumped long distances [PEI installations are up to 900 metres (3,000 ft)].
- Water is conveyed in polyethylene pipe ranging in size from 1.9-3.2 cm (.75-1.25 in) diameter.
- Polyethylene pipe can be buried below frost or laid on top of the ground.
- If pastures are at an elevation below the farm well, water can be gravity fed to the watering stations.
- Capable of watering large numbers of livestock.
- Ideal for intensive grazing systems. Water can be readily made available in each paddock. This will reduce the distance cattle need to travel and increase productivity.
- Dependable in winter with the use of either energy-free or electric bowl technologies.

Gravity flow systems:

- Will work on sites where there is sufficient elevation difference along a length of a watercourse for water to gravity flow through a pipe from an upstream location to a watering tank.
- Works best on a watercourse with grades along its length that are greater than 3% and with stream banks that are not significantly higher than the stream bed. Most PEI streams have grades less than 1%, thus making it difficult to install an in-stream system.
- Pastures with continuous flowing springs on the upper slopes are excellent candidates for gravity flow systems. A continuous flow of water from the spring can be gravity fed through a polyethylene pipe to a watering tank. The water level in the watering tank is controlled by a second pipe that discharges the overflow back to the stream.
- Greatest advantage is that they do not require any type of pumping equipment.
- Dependable, low cost and low maintenance.
- Capable of watering large herds.
- Dependable in winter.
- Less flexible than farm wells when used with intensive grazing systems.

Hydraulic ram pumps:

- Installed in running water. The falling water produces a hammering effect in the hydraulic

Livestock operating a pasture nose pump system to water.

- Every 30 cm (1 ft) of vertical drop in the pump will produce 300 cm (10 ft) of vertical lift.
- Capable of watering large numbers of livestock if water is pumped to a reservoir that feeds the stock watering tank.
- Poor option for intensive grazing system.
- These pumps can offer reliable service but require an appropriate location, good system design and proper installation.

Pasture nose pumps:

- Operated by a cow pushing its nose against a lever which primes the pump and delivers approximately 1 litre (0.2 gal) of water into the bowl.
- Can lift water up to 8 metres (27 ft) vertically and 38 metres (125 ft) horizontally.
- Will work with any water source that has at least a 15 cm (6 in) depth of water at all times.
- Easy to install and easy to relocate.
- A single pump can supply water for up to 30 head of cattle. However, the number of head per pump is a function of pasture size. On large pastures where cattle tend to water as a group, the number of head watered per pump should be reduced because only one animal can water at a time. Multiple pump installations are practical with larger herds.
- Not suitable for young calves because they have difficulty operating the pump.
- Not dependable when temperatures drop below freezing point.

Bilge pumps:

- A bilge pump is a marine sump pump that is placed directly into a watercourse and is usually powered by a 12 volt battery.
- Capable of supplying large volumes of water [1-2 litres/second (1000-2000 gal/hr)] over a short time period.
- Low cost and portable system.
- Management required to charge and switch 12 volt batteries after a few days of operation.
- Unable to pump water over long distances, therefore watering stations are usually located 3-4.5 metres (10-15 ft) from the edge of the stream.

Solar systems:

- Use the power of the sun to charge a 12 volt pumping station.
- A water reservoir is recommended in addition to the stock tank to allow for reduced efficiency on cloudy days.
- Can be custom-designed based on topography and the number of head to be watered.
- Ideal for large pastures at remote sites.
- Not cost effective under intensive grazing systems.

Wind powered pumps:

- Wind power is an alternate energy source that can be applied to pumping water for livestock.
- These systems are very common in Western Canada but have not been used extensively on PEI in recent times and would require further evaluation for local conditions.

Waste Forage

Waste forage is a normal by-product of any livestock feeding system. It includes waste hay, waste silage and silage effluent.

Hay

When hay is harvested, it is allowed to dry to less than 15% moisture. When it is stored and fed, it poses no environmental hazard. Hay that is wasted during feeding usually becomes incorporated with the straw and manure.

Silage

The potential for waste from silage feeding systems also exists. However, because silage is harvested and stored at a much higher moisture content than hay, there is also the potential for leachate or seepage waste from storage areas. Silage can be stored in vertical silos, horizontal silos, or in round bales wrapped in plastic.

Waste forage being used as a mulch for erosion control after potato harvesting

Environmental Concerns

While forage waste is costly to producers, it is also an environmental concern.

- Silage seepage can leach into the groundwater and can contaminate watercourses if runoff is not controlled.
- Burning waste forage can cause nuisance odours and contribute to air pollution.
- Silage waste can also create nuisance odours.

Best Management Practices

Reduce waste forage by:

- Storing bales of hay under cover.
- Harvest and store only as much forage as will be required for the coming year.
- Harvest silage at the optimum moisture content to minimize the potential for seepage.
- Use waste forage as a mulch to provide protection from soil erosion in recently harvested potato fields rather than hauling it to the woods or burning it. It will add organic matter to cultivated soils.
- Co[illegible]

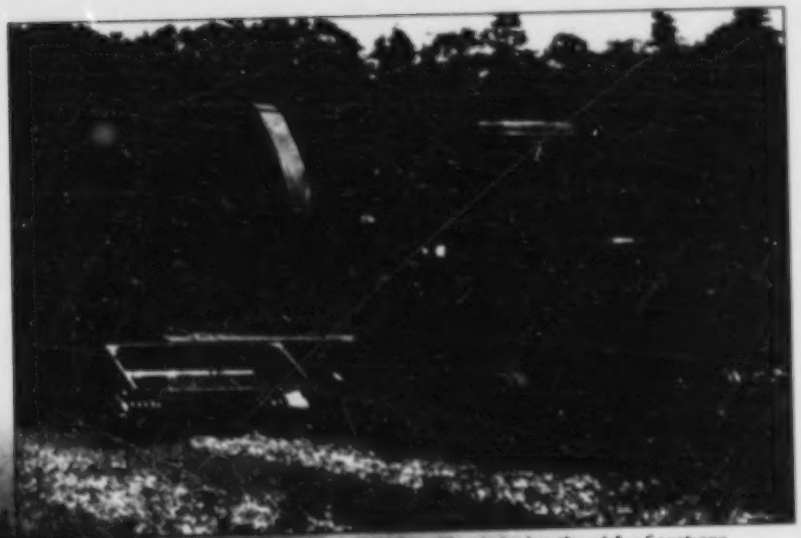
Seepage From Farm Silos

Silage seepage presents several concerns for the agricultural industry.

- Contamination of surface and groundwater.
- Deterioration of the silo structure.
- Odours.

Silage effluent has extremely high BOD values, which are approximately 200 times as strong as raw domestic sewage. A significant discharge of effluent into a watercourse can remove so much oxygen that fish and other aquatic creatures die immediately.

With respect to groundwater quality, silage leachate contains nutrients, acids, minerals and bacteria. Nitrate-nitrogen is the most significant groundwater contaminant from this group. The greatest percentage of silage seepage is produced within 5 to 10 days after filling the silo.



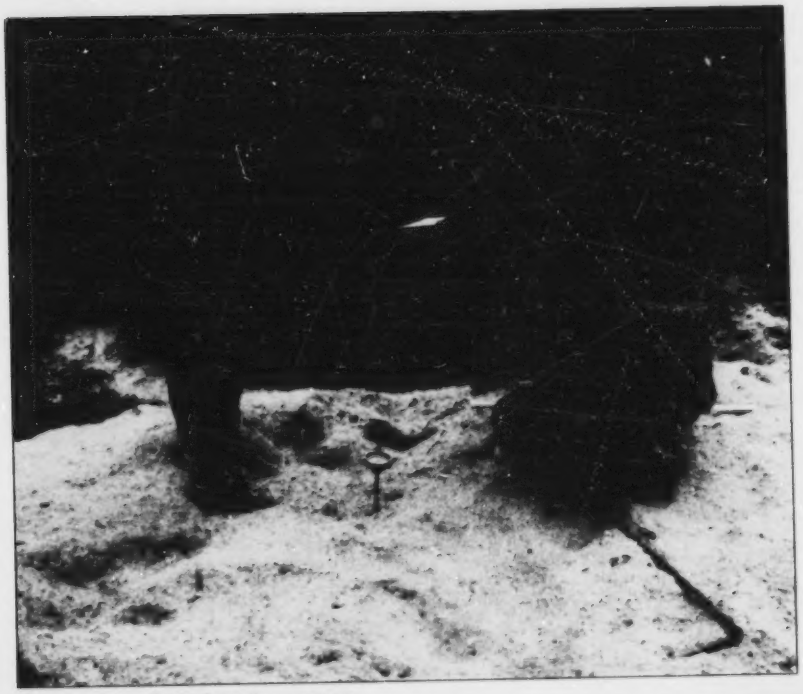
Proper silage moisture levels will minimize the risk of seepage.

Best Management Practices

- Seepage from the silo, along with the surface water runoff from open bunker silos, should be collected and stored since this material is highly contaminated. During the cropping season this contaminated material can be spread regularly on land.
- Harvest silage/haylage at low moisture, i.e. below 60% moisture content for tower silos and below 65% for horizontal silos.
- Adding absorbents which are designed to take up excess moisture will result in low or no seepage production. Material that can be used include oatmeal, dried sugar beet pulp and dried corn cobs. To be effective, enough material must be added to absorb the anticipated seepage.
- Silos should be covered - this prevents rain water from entering and leaching through the silage/haylage.
- Divert all surface water away from the silo site.
- For new silos, install seepage collection and storage systems.

Dead Stock Disposal

The disposal of dead animals must be in accordance with the *PEI Guidelines for Disposal of Dead Farm Livestock*. These guidelines are designed to protect the public and animal health and to reduce the risk of contamination of drinking water supplies and surface water resources. All livestock and poultry operations need a management plan for dead animals. Afterbirth in livestock operations and eggs in poultry operations are additional wastes which should be handled in a similar manner.



Composting of dead stock carcasses.

Environmental Concerns

Dead animals are a health risk to humans and farm animals. They may be carriers of disease. If not promptly removed or disposed of, carcasses will also attract rodents, flies, and nuisance wildlife, as well as producing offensive odours.

Options for Disposal

Dead animals should be removed from the building as soon as possible and disposed of in an approved manner within one day. Livestock and poultry cannot be disposed of in manure storage or be spread onto the land with manure. Under no circumstances should dead animals be left lying around the farm buildings for an extended period of time. Feeding carcasses to wildlife is not an acceptable disposal method and should not be used.

While health and environmental concerns are most important, ensuring that disposal activities are not unsightly will create good will in the community. Trees, shrubs and windbreaks can be used to screen disposal sites.

Disposal options are covered in order from most to least acceptable.

• ***Dead Animal Removal Service***

A dead animal and poultry removal service removes carcasses to be rendered. Poultry and other small animals must be stored in freezers and held for pickup. Livestock should be picked up within 48 hours of death. For a current list of livestock removal companies, call the PEI Department of Agriculture and Forestry.

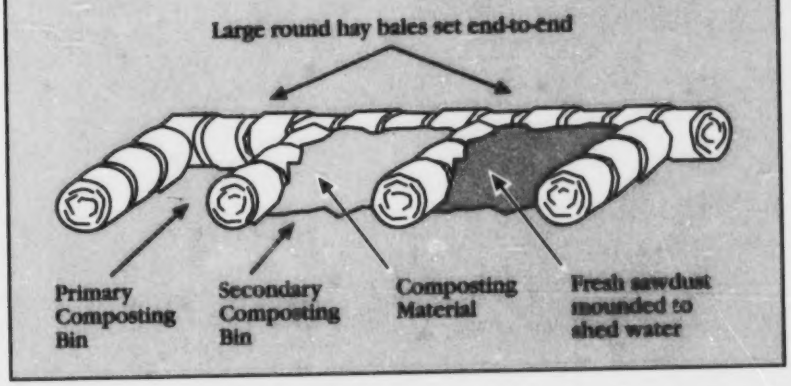
• ***Composting***

Composting of poultry and other small agricultural animals is considered a low cost, environmentally acceptable method of disposal of dead stock. The use of composting technology in the disposal of poultry and hogs is becoming more widespread.

Some basic requirements for carcass composting are:

- An aerobic environment must be maintained.
- A carbon source will be required to ensure that the proper carbon:nitrogen ratio of 25:1 is present for the composting process to take place. Sawdust is an ideal carbon source.
- Temperatures throughout the compost pile must exceed 55°C (130°F) for adequate reduction of pathogen levels.
- Moisture content of the compost pile should be in the 50-60% range.
- The composter should be located in an area that is well drained, accessible and away from areas that are sensitive to groundwater contamination. If a facility is constructed for composting, it should consist of a concrete pad, roof, and rot-resistant construction materials.
- The composting site must be located a minimum of 90 metres (300 ft) from a watercourse or domestic well.
- All contaminated runoff from the compost site must be collected. Clean surface water should be directed away from the composting facility.
- The finished compost can be spread on the land.
- Capacity of the composting facility must be sufficient to dispose of the normal mortality rate. Expanded capacity to contain an excessive mortality rate is desirable but not essential.

Sample Composter Layout Using Hay Bales


Large round hay bales set end-to-end
Primary Composting Bin
Secondary Composting Bin
Composting Material
Fresh sawdust mounded to shed water

Additional information for on-farm composting of dead stock can be obtained from the PEI Department of Agriculture and Forestry fact sheet "Composting of Swine Carcasses - Turning a Problem into an Asset".

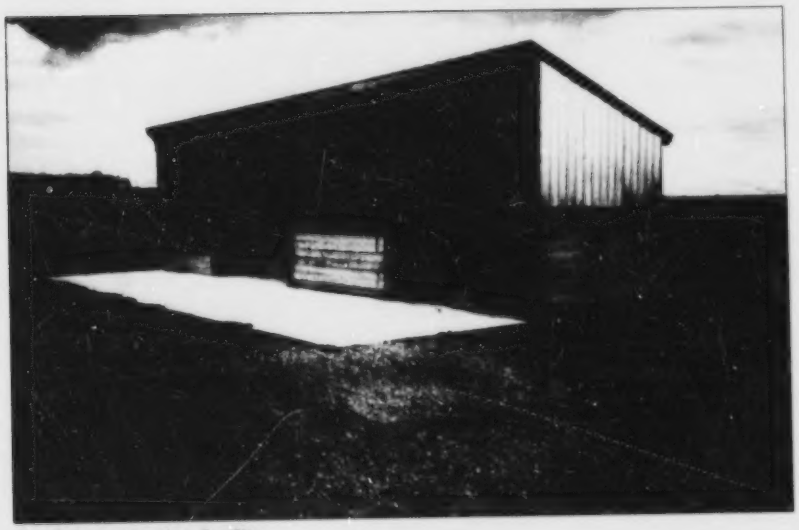
• ***Subsurface Burial***

Burial should be considered only as a last resort. Subsurface burial is not recommended due to the potential for groundwater pollution. It is permitted as long as the criteria listed below are met. Burial sites should be staggered throughout the property, not concentrated in one location. Burial sites must be located:

- at least 300 metres (1,000 ft) from any drinking water supply or well. With prior written approval from the Department of Fisheries, Aquaculture and Environment, a burial site may be located closer than 300 metres (1,000 ft), but at no time will the Department approve a site less than 150 metres (500 ft) from a drinking water source.
- at least 60 metres (200 ft) from any fresh water stream, pond, estuary or coastal area.
- at least 30 metres (100 ft) from any public right of way.

All buried poultry and livestock must be covered on the same day they are buried with a minimum of 0.6 metres (2 ft) of earth. Subsurface burial should only be considered under the following conditions.

- At locations where the water table does not come within 600 mm (24 in) of the pit bottom and where soil is well aerated.
- At locations where the floor of the burial pit is at least 0.6 metres (2 ft) above bedrock.
- At locations not subject to surface runoff, ponding or flooding.
- Open trench pits are not acceptable.



Roofed composting facility.

M121

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Section C - Potato/Vegetable Waste Management

Potato production is a large and growing industry on Prince Edward Island. This success in production is accompanied by an increase in the volume of wastes associated with grading and processing. These wastes include culls, diseased product, washline sediment and processing plant effluent.

Environmental Concerns

- Potato/Vegetable wastes pose a plant health issue for the industry as diseases such as ring rot, blight and viruses can be spread from culls that are not properly disposed of.
- Proper storage and disposal is required to protect ground and surface water.
- Odour generation from decomposing waste can be a nuisance to neighbours.

Options for Disposal

Disposal options are covered in order from most to least acceptable.

- value-added processing
- animal feed
- composting
- land spread
- burial

Value-Added Processing

Dehydration of cull and other waste potatoes (smalls) is a very effective and efficient method of turning a waste material into a value-added product. This process dehydrates the raw potato into dry material such as potato flakes and granules. These products are used in the food industry to create new recompositioned potato and other food products. On Prince Edward Island, the dehydration process can handle upwards of 200 tonnes/day of waste potatoes.

Nature of Waste	Disposal Options				
	Dehydration & Processing	Animal Feed	Composting	Land Spread	Burial
Culls	✔	✔	✔	✔	✔
Diseased Products	✖	✖	✔	✖	✔
Rock/Low Organic	✖	✖	✖	✔	✔
Wash Line Sediment	✖	✖	✖	✔	✔
Processing Plant Waste	✖	✔	✔	✔	✖

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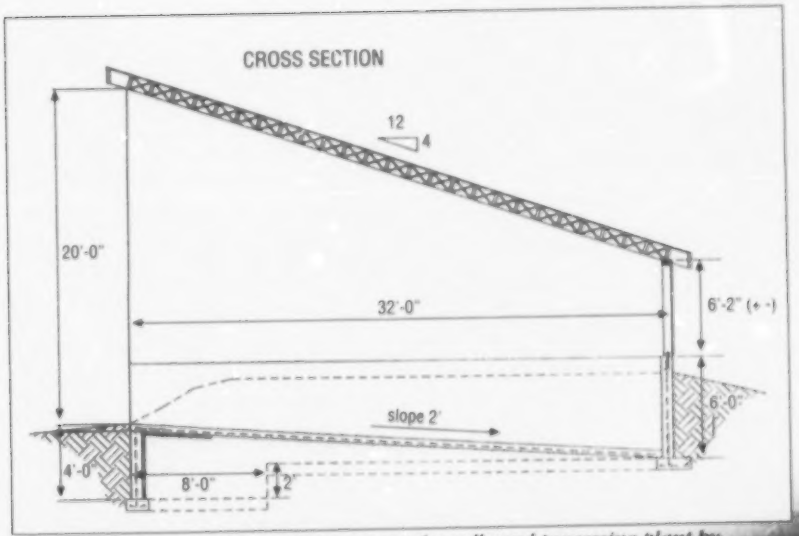
Wash Line Sediment	✖	✖	✖	✔	✔
Processing Plant Waste	✖	✔	✔	✔	✖

Potato dehydration plant.

This process also generates other waste streams. The recommended disposal options for these waste materials is as follows:

- Low organic waste (rocks and silt): silt is returned to the land, rocks are buried.
- Wastewater: treated to approved standards and discharged.
- Waste sludge from treatment process: land applied in accordance with regulations.



Typical cross section of an on-farm storage for culls and processing plant by-products.

Animal Feed

Cull potatoes and processing vegetable wastes are an excellent energy source suitable for finishing rations in beef feedlots.

Culls and processing plant wastes are normally delivered to the farm in 10-30 tonne loads. These products should be stored away from direct sunlight in a three-sided concrete storage with a roof. The concrete floor in the storage should be sloped to the back to retain seepage. Ideally, a potato waste storage should be located beside a manure storage to allow drainage of excess liquid into the manure storage.

Cull potatoes and processing plant wastes can also be ensilaged. Advantages of ensiling include a longer storage life, more consistent quality product and a better insurance of continuous supply. Potato waste can be ensiled by itself in a bunker if the product is chopped or pureed prior to ensiling. It will take 7-10 days for potato waste to ensile and it is preferred that the material is not fed within 21 days. Alternatively, potato culls and processing plant wastes can be ensilaged by placing them in layers in the silo with well-wilted hay crop silage at a 2:1 ratio. A mixture of three parts potato waste to one part chopped hay can also be ensilaged.

Composting

The composting of cull potatoes and other vegetable wastes including diseased products is an environmentally acceptable method of disposal.

Mix Ratios for Potato Composting (by volume)			
Ratio	**Parts**	**Parts**	**Parts**
3:3:1	3 sawdust	3 potatoes	1 manure
2:1	2 manure*	1 potato	
2:1	2 straw•	1 potato	
2:1	2 leaves•	1 potato	

Notes:
*Wet, sloppy manure will not work
•Both straw and leaves are bulky and work best if they are wet prior to being added to the pile.

The microorganisms which break down the ingredients in a compost pile require specific amounts of carbon and nitrogen for the composting process to work effectively. To obtain the correct amounts of carbon and nitrogen, potatoes must be mixed with other materials for effective composting. Common materials which can be mixed with potatoes are sawdust, straw and solid manure.

The On-Farm Composting of Manure section (p. 24) contains additional information on composting methods and guidelines. A fact sheet on potato composting techniques is available from the Department of Agriculture and Forestry.

Land Spread

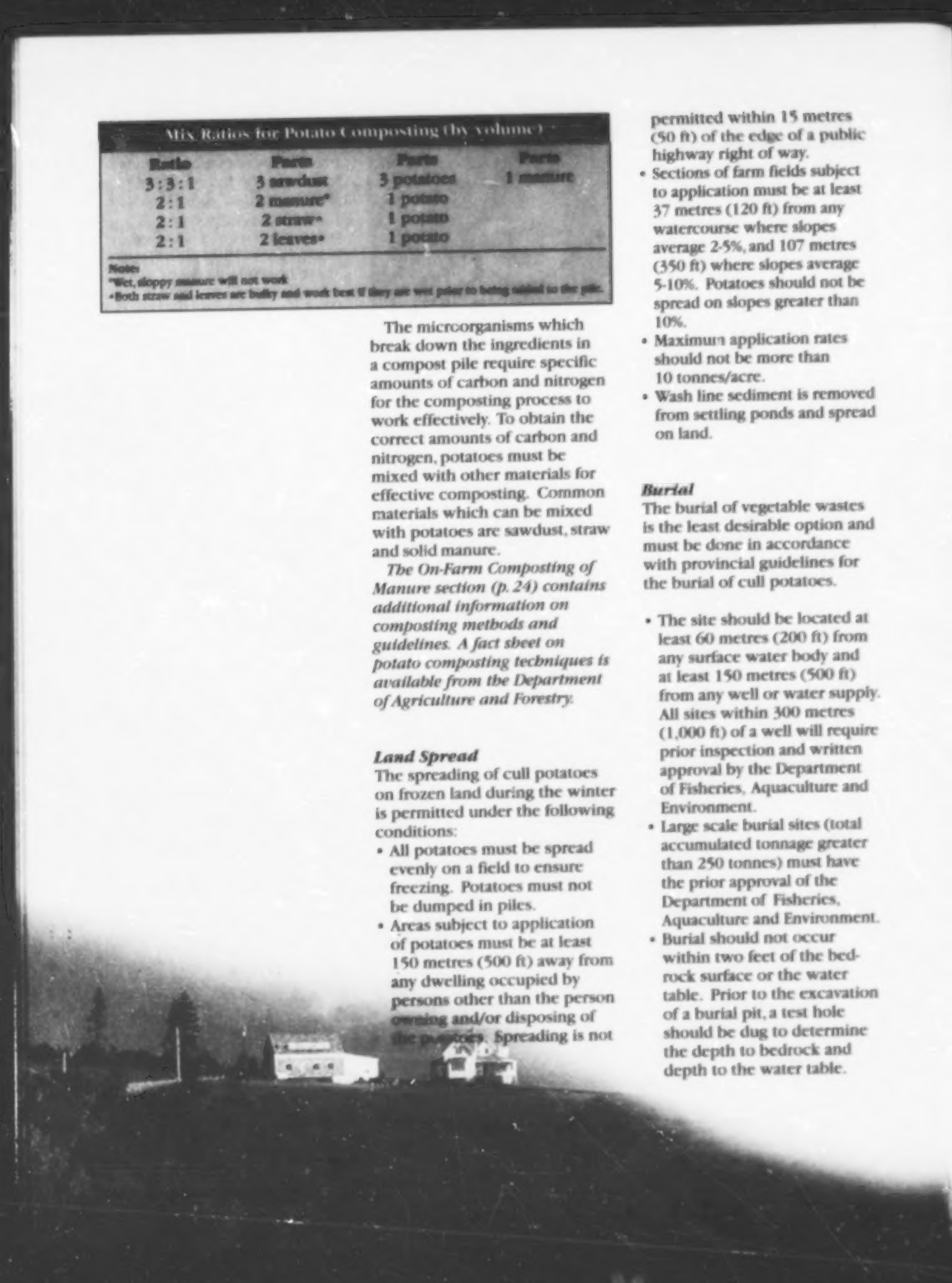
The spreading of cull potatoes on frozen land during the winter is permitted under the following conditions:

- All potatoes must be spread evenly on a field to ensure freezing. Potatoes must not be dumped in piles.
- Areas subject to application of potatoes must be at least 150 metres (500 ft) away from any dwelling occupied by persons other than the person owning and/or disposing of the potatoes. Spreading is not permitted within 15 metres (50 ft) of the edge of a public highway right of way.
- Sections of farm fields subject to application must be at least 37 metres (120 ft) from any watercourse where slopes average 2-5%, and 107 metres (350 ft) where slopes average 5-10%. Potatoes should not be spread on slopes greater than 10%.
- Maximum application rates should not be more than 10 tonnes/acre.
- Wash line sediment is removed from settling ponds and spread on land.

Burial

The burial of vegetable wastes is the least desirable option and must be done in accordance with provincial guidelines for the burial of cull potatoes.

- The site should be located at least 60 metres (200 ft) from any surface water body and at least 150 metres (500 ft) from any well or water supply. All sites within 300 metres (1,000 ft) of a well will require prior inspection and written approval by the Department of Fisheries, Aquaculture and Environment.
- Large scale burial sites (total accumulated tonnage greater than 250 tonnes) must have the prior approval of the Department of Fisheries, Aquaculture and Environment.
- Burial should not occur within two feet of the bedrock surface or the water table. Prior to the excavation of a burial pit, a test hole should be dug to determine the depth to bedrock and depth to the water table.



Section D - Farm Plastics and Other Wastes

Farms generate a number of other waste materials. These include plastics, chemicals, empty containers, building materials, old machinery, animal health care products and petroleum wastes.

From waste to usable by-product - silage wrap converted to plastic lumber.

Picnic table constructed from recycled plastic.

Farm Plastics

Plastics are used on the farm in a variety of manners. These include silage wrap and nylon twine. Plastic film placed on the surface of the soil to enhance heat retention is a new technique used in agriculture. It is also used for cover and storage of forages.

Proper Disposal of Farm Plastics

The most ideal method of disposal of farm plastics is to convert the waste into a usable by-product such as building materials, fence posts, recreational furniture or recycled silage wrap. A manufacturing facility is in operation on Prince Edward Island. Landfilling or burning of farm plastics is not recommended.

The Island Waste Management Corporation will accept clean, dry silage wrap at the East Prince Waste Management Facility. Residents of the East Prince area may contact the corporation office for their disposal needs.

Steps in Off-Farm Recycling of Plastic Wrap

- **Once the plastic wrap is removed, shake it to remove contaminants (dirt, haylage, water, ice, etc.). Separate strings from the plastic.**
- **Store plastic wrap indoors. This will keep it from further contamination and degradation by sunlight. Some farmers store plastic on hay wagons inside machinery sheds.**
- **Keep plastic clean and dry.**
- **Bale or compact into small square bales for easier handling, storing and transporting. Bale only with plastic string.**

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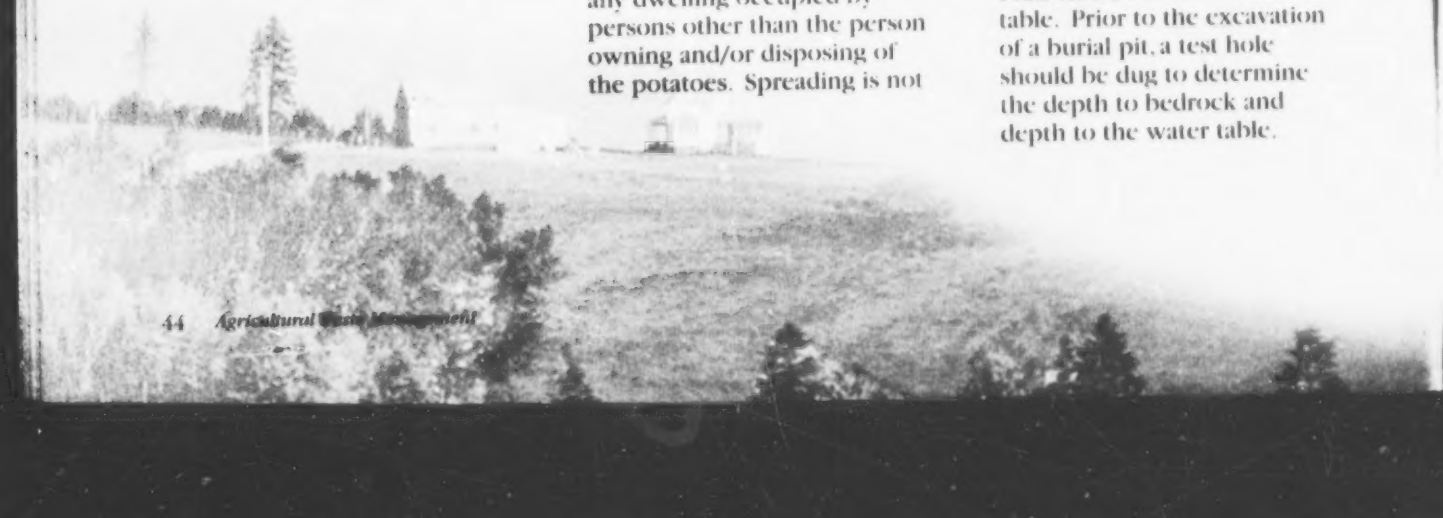

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Pesticide Containers

Containers made from plastic are the most common type used to hold liquid pesticides. Paper bag containers are used to hold pesticides which are sold in a granular or powder form.

The disposal of empty pesticide containers in Prince Edward Island is regulated under the provincial Pesticide Control Act.

Rinsing Containers

Rinsing containers removes pesticides left in the container after emptying. Removing this pesticide:

- **Saves money**. Throwing away pesticide in an "empty" container is throwing away money.
- **Reduces chances of exposure**. Pesticide left in a container can poison people, livestock or wildlife.
- **Reduces chances of contamination**. Pesticide left in a container can contaminate soil, surface water or groundwater.

Containers should be rinsed immediately after use. Waiting too long allows the pesticide solution to dry out inside the container, making rinsing difficult and lessening the probability of meeting clean standards.

The recommended method of rinsing pesticide containers is triple-rinse.

- Fill empty container about 1/4 full with water and replace cap securely.
- Swirl and shake the container to rinse all inside surfaces and the handle cavity.
- Pour contents into spray tank. Let contents drain for 30 seconds after container is "empty".
- Repeat three times until container is clean. Final rinse water should be clear.

Paper bag containers that have a plastic or foil lining should be single-rinsed. Even after rinsing, trace amounts of the pesticide may remain.

All containers not being recycled should be punctured or crushed so that they cannot be used again for any other purpose.

Disposing of Plastic Containers

The recommended way to dispose of empty plastic pesticide containers is to return them to the pesticide dealer for recycling. Pesticide manufacturers and dealers have developed a container collection program which recycles empty plastic containers. All licensed pesticide dealerships accept empty plastic containers. Containers must be clean, triple-rinsed, and contain no liquid material. There are approximately 2-3 million plastic containers recycled each year in Canada. In 1998, the container collection program recycled over 75% of all plastic containers sold on Prince Edward Island.

Burning Containers

The on-farm burning of plastic containers or hazardous substances is prohibited by law under the Environmental Protection Act - Air Quality Regulations. Low temperature burning does not destroy the remaining pesticides but results in them being vaporized and drifting to other areas. The breathing of smoke from these fires can be harmful.

Burying Containers

The burying of empty pesticide containers, even if they have been properly rinsed, is not recommended. While properly rinsed containers do not pose an environmental threat, the decomposition rate is very slow. A plastic container may take several centuries to break down. A plastic fence post made from recycled plastic is a much better gift to your grandchildren.

Paper Bag Containers

The recommended way to dispose of empty paper bag containers is to take them to a provincial landfill site or the Energy From Waste Plant. Strict regulations governing what can be disposed of in landfill are enforced by the Department of Fisheries, Aquaculture and Environment. Before pesticide containers can be accepted at a landfill, a disposal permit must be obtained from the Department of Fisheries, Aquaculture and Environment. The recommended way to dispose of any other empty pesticide container that cannot be recycled is to take it to a provincial landfill site.

How to get a Disposal Permit

Producers can call (368-5000), fax (368-5830), or write (Department of Fisheries, Aquaculture and Environment, P.O. Box 2000, Charlottetown, PEI, C1A 7N8) to request a disposal permit for plastic or paper bags. A request for a disposal permit must state the name and address of the producer as well as the number of containers being disposed of, type of container, size of the container, former contents of the container, and a statement that each container has been properly rinsed or emptied. At the time of delivery of the empty containers to the landfill, landfill site personnel will verify that the containers being delivered are the same as the permit states.

Site personnel will also inspect the containers to ensure that they are properly rinsed, empty and punctured/crushed. The two designated landfill sites are in Sleepy Hollow and Wellington Centre.

Excess Pesticide Product Disposal

Unfortunately, as of now, there is no official pesticide disposal facility on PEI. Pesticide waste is still taken off-island to facilities on the mainland. In November 1998, an Agricultural Clean-up Day was very successful. A great amount of old and excess pesticide was collected and trucked off the island to be disposed of in the proper way. Until PEI has a disposal facility, farmers are encouraged to use the following suggestions to help keep excess product levels down:

- Practice responsible purchasing. Buy only the amount of pesticide that will be totally consumed by the farm.
- Pass on excess pesticides to other producers who can make use of them.
- Small operators may wish to buy pesticides as a group with other small operators, thereby reducing waste. This may also be a cost saving measure for operators.

Until a collection is organized, producers are advised to store excess pesticides in their original container in a safe, dry area away from food, pets, children, and water wells.

OTHER FARM WASTES

Animal Health Care Products

Animal health care products include drugs, medicines, ointments, insect repellants, vaccines, needles, applicators, disinfectants, cleaners, rodenticides and fumigants. If animal health care products are improperly disposed of, they can present health and safety risks to people (especially children), farm animals, pets and wildlife.

- Try to use products for their intended and registered purpose before they become outdated or contaminated.
- It is best to store products in their original container in a clean, dry, frost-free area such as a farm office or utility room. The storage area should be locked.
- The product label often gives advice on storage, but if you are unsure, your veterinarian or supplier would be able to help. Typical storages include locked refrigerators and insulated cabinets.

- Unused animal health care products should be left with a veterinarian for disposal. If this is not possible, syringes and drugs should be placed in a labelled, puncture-proof container and delivered to the Energy From Waste Plant or an approved waste disposal site.

Farm Building Materials

Even though many building materials will not adversely affect the environment, the preserving materials on many of them could cause problems. Dumping, burying or burning this material on the farm is unacceptable because it could cause pollution and be dangerous for people, especially children. Piles of building materials make excellent havens for rodents.

Reusable building materials should be separated and stored for future use. Remaining excess construction materials should be taken to an approved site for disposal.

Machinery and Equipment

Machinery, equipment, stoves, refrigerators, bulk tanks and water heaters become outdated and must be replaced.

- Reusing or repairing old components can make good economic sense. Unusable equipment can be sold to scrap dealers. Before equipment is taken, remove any hazardous materials such as antifreeze, oils or fuels.
- Stoves, refrigerators, water heaters, etc. can be taken to a provincial landfill (white goods area) where the items will be crushed, bailed and recycled. A contractor is hired by the province to recover the ozone-depleting substances from refrigerators before they are crushed.
- All tires should be brought to an approved disposal location.

Used Oil

The dumping or burning of oil on the farm is not permitted. The provincial Used Oil Handling Regulations require sellers of lubricating oil to operate a return facility. Used oil, therefore, can be returned to any dealer on the Island.

Acknowledgements and Bibliography

The Best Management Practices for Agricultural Waste Management Booklet was funded under the Canada-Prince Edward Island Water Annex to the Federal/Provincial Framework Agreement for Environmental Cooperation in Atlantic Canada.

Participating Agencies

PEI Department of Fisheries, Aquaculture and Environment, PEI Department of Agriculture and Forestry, Environment Canada and Agriculture and Agrifood Canada.

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Photography

Barrett & MacKay, Ron DeHaan, Delbert Reeves, Tom Duffy, Graeme Linkletter, Russell Campbell, Allan Campbell, Jane Palmer, Jamie Coffin, John MacLeod, Shane Murphy.

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